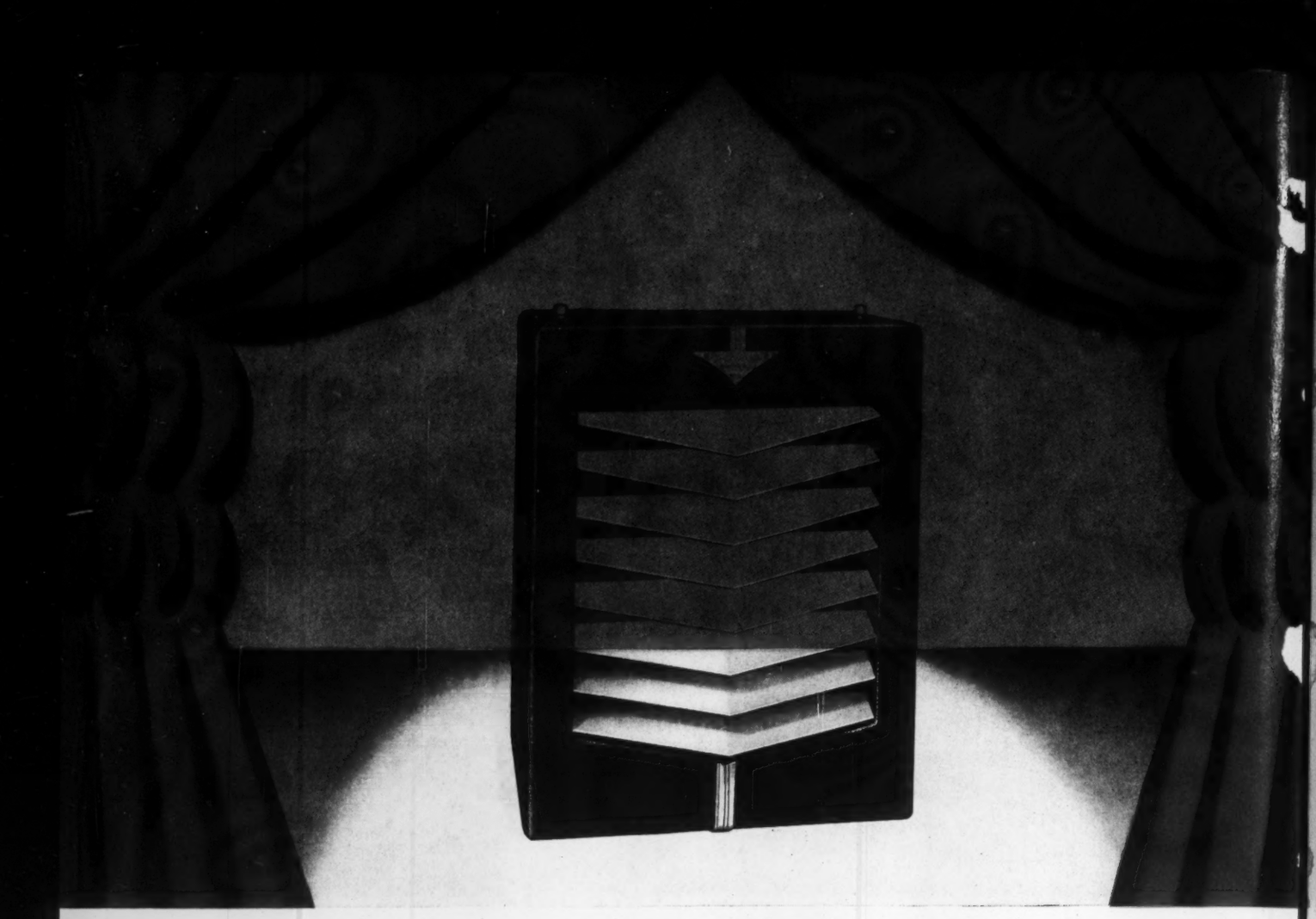
MAR 8 1937

Heating · Piping and Air Conditioning

Of unusual design is the complete hospital air conditioning installation described in this issue (page 155). Absorption by lithium chloride and mechanical refrigeration are combined to meet the design requirements



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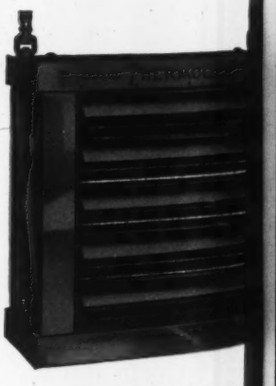

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THE UNIT HEATER WITH 14 POINTS OF SUPERIORITY

THE EDITOR'S PAGE

■ **$200,000 in awards** will be distributed by The James F. Lincoln Arc Welding Foundation among the winners of 446 separate prizes for papers dealing with arc welding as a primary process of manufacture, fabrication, or construction. Purpose of the competition, one of the richest ever announced in the mechanical science field, is to stimulate extensive study of arc welding and the new ideas which it will bring forth are expected to benefit industry at large. . . . To assure equal competitive opportunity, similar prizes are offered in eleven major divisions—and many sub-divisions—which are automotive, aircraft, railroad, watercraft, structural, furniture and fixtures, commercial welding, containers, welderies, functional machinery, and industrial machinery. The "containers" classification is split into sub-classifications on "contents stationary" and "contents moving," the first of which includes tanks, etc., and the second all kinds of piping. . . . Papers must be on file with the Foundation's secretary not later than June 1, 1938; complete details of the rules and conditions covering the awards may be had from the secretary, A. F. Davis, P. O. Box 5728, Cleveland, Ohio.

■ **Sharp increases** in air conditioning installations contracted for this year are reported in several cities, indicating 1937 should be a "banner year." Here are some figures:

City	*Jan., 1936*	*Jan., 1937*
Baltimore	56 hp	412 hp
Chicago	485 hp	1654 hp
Cincinnati	172 hp	1480 hp
Detroit	35 hp	699 hp
Philadelphia	14 hp	1062 hp
Pittsburgh	5 hp	1724 hp
St. Louis	182 hp	2126 hp

Total horsepower for air conditioning for these seven cities for January, 1937, is therefore 9157, compared with 949 hp for January, 1936, or a gain of over 800 per cent. Similar gains were expected for February, 1937, over the corresponding month of 1936, but figures were not available at press date.

■ **"The Business Digest"** published as its lead article last month an abstract of Walter L. Fleisher's discussion of the future of air conditioning which appeared originally in the January HEATING, PIPING AND AIR CONDITIONING. From the same number of H. P. & A. C., "The Economist" reprinted Rex E. Hieronymus' article on setting up a heat economy program. . . . Arthur Nutting received so many requests for extra copies of his chart for the design of exhaust systems, the use of which he described in our January issue, that he had reprints made.

■ **The Washington Award** for 1937 was bestowed on Dr. Frederick Gardner Cottrell because of his "social vision in dedicating to the perpetuation of research the rewards of his achievements in science and engineering." Fourteenth of the distinguished engineers to receive this award, which is made jointly by the Western Society of Engineers, A.S.M.E., A.I.E.E., A.S.C.E., and A.I.M.M.E., Dr. Cottrell is well known for his work in the electric precipitation process for removing solids from gases . . . The appointment of the eminent Dr. Max Jakob, formerly of Berlin, as head of the research laboratory of Armour Institute of Technology, Chicago, was recently announced.

■ **Office space occupancy** in the United States and Canada is at a new high since January 1, 1932, according to a quarterly survey by the National Association of Building Owners and Managers reported in "Skyscraper Management," the rate of occupancy the first of the year being 79.49 per cent. . . . Officers of the Industrial Unit Heater Association for the current year, elected at a meeting attended by some 20 manufacturers, are: President, John M. Frank, Ilg Electric Ventilating Co.; Vice-president, A. G. Dixon, Modine Mfg. Co.; Secretary, L. O. Monroe. . . . . William J. O'Neil, Iron Fireman Mfg. Co., was elected president of the Midwest Stoker Association last month; H. L. Bilsborough, Fairbanks, Morse & Co., was named vice-president and J. E. McClintock, Illinois Iron & Bolt Co., secretary-treasurer. . . . The American Welding Society has announced acceptance of the "Lincoln Gold Medal" to be presented to the author of the best paper on welding published in the Society's journal during the year ending October, 1937. J. F. Lincoln, The Lincoln Electric Co., offered the award as a stimulus to the welding art. . . . Three industrialists and a representative of the U. S. Bureau of Mines were added to the board of trustees of the Air Hygiene Foundation at its annual meeting last month; more than 100 firms have affiliated with the Foundation since the first meeting last November.

■ **To every business** executive, air conditioning is either a threatening factor or a powerful ally, according to the "Business Conditioner" of the Air Conditioning Bureau of Omaha; air conditioning must be reckoned with in almost every line of business. . . . Stipulation No. 1883 of the Federal Trade Commission is of interest and importance because it gives the Commission's definition of the term "air conditioning." The stipulation states: "The words 'air conditioning' signify the simultaneous control by a mechanical device of various factors affecting both the physical and chemical conditions of the atmosphere within a given structure as a room, building, and the like, said factors including temperature, humidity and motion or circulation of the air within the structure. A device which does not control each and all of the designated factors is not properly represented, designated or referred to as an air conditioner within the purview and meaning of these words as generally understood by the trade and public."

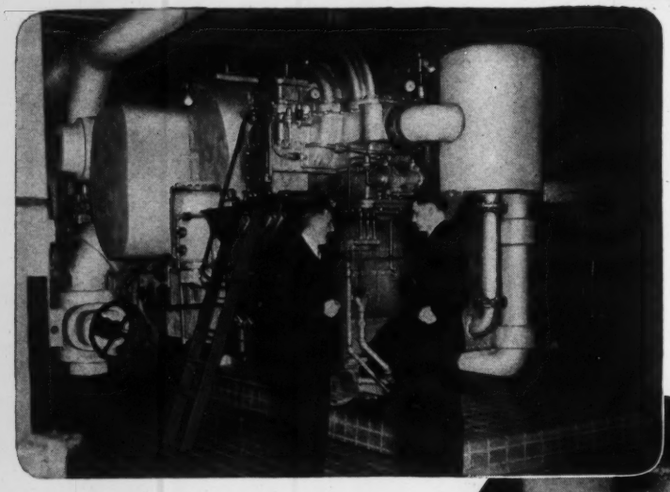
■ **A new name** appears as a member of H. P. & A. C.'s Board of Consulting and Contributing Editors (page 53) this month—that of William Goodman, frequent contributor to our pages, author of the excellent series of articles on solving heat transfer problems which concludes this month and which is briefed in the first of our "Heating, Piping and Air Conditioning Summary Sheets" on pages 179 and 180.

■ **Mine Air Conditioning**—Installation in the Magma copper mine, Arizona, of the first mine air conditioning system with mechanical refrigeration in the United States was announced last month by Willis H. Carrier, speaking before a joint meeting of the Air Conditioning Bureau, the American Metallurgical Society, and several other engineering groups, at Boston. The equipment, at the 3600 and 3400 ft levels, was designed to cool and reduce the humidity of the mine during all seasons; it will also be used to cool new portions of the mine before they are worked. Normal temperatures at present at the 3400 and 3600 ft levels range from 95 to 100 deg with very high humidity. . . . Two centrifugal compressors will provide 300 tons cooling effect. One of the unusual conditions in this installation is the hot mine water in the condensers, with the abnormal temperature of 111 deg when leaving the condensers.

Detroit Department Store to have WORLD'S LARGEST SYSTEM with Carrier Air Conditioning

1. Talking It Over . . . Vice-President Heckel of Carrier Corporation (left), and Architect Walton (standing) discuss with General Superintendent Wright, plans for increasing Hudson's air conditioning system to the largest in the world—with refrigeration totaling more than 5,000 tons—and capacity for 1,200,000 square feet of floor space.

Addition to J. L. Hudson Co. System Will Total 5,000 Tons of Refrigeration



2. Responsible for maintenance of the J. L. Hudson Co. store are Chief Engineer Warr and Building Superintendent Netting, shown inspecting one of the Carrier Centrifugal Refrigerating machines located in the third basement. Eleven of these mammoth machines will soon be on the job.

3. Checking Up. What's the temperature and humidity in, say, the fur department? Chief Engineer Warr knows immediately by referring to this continuous report.

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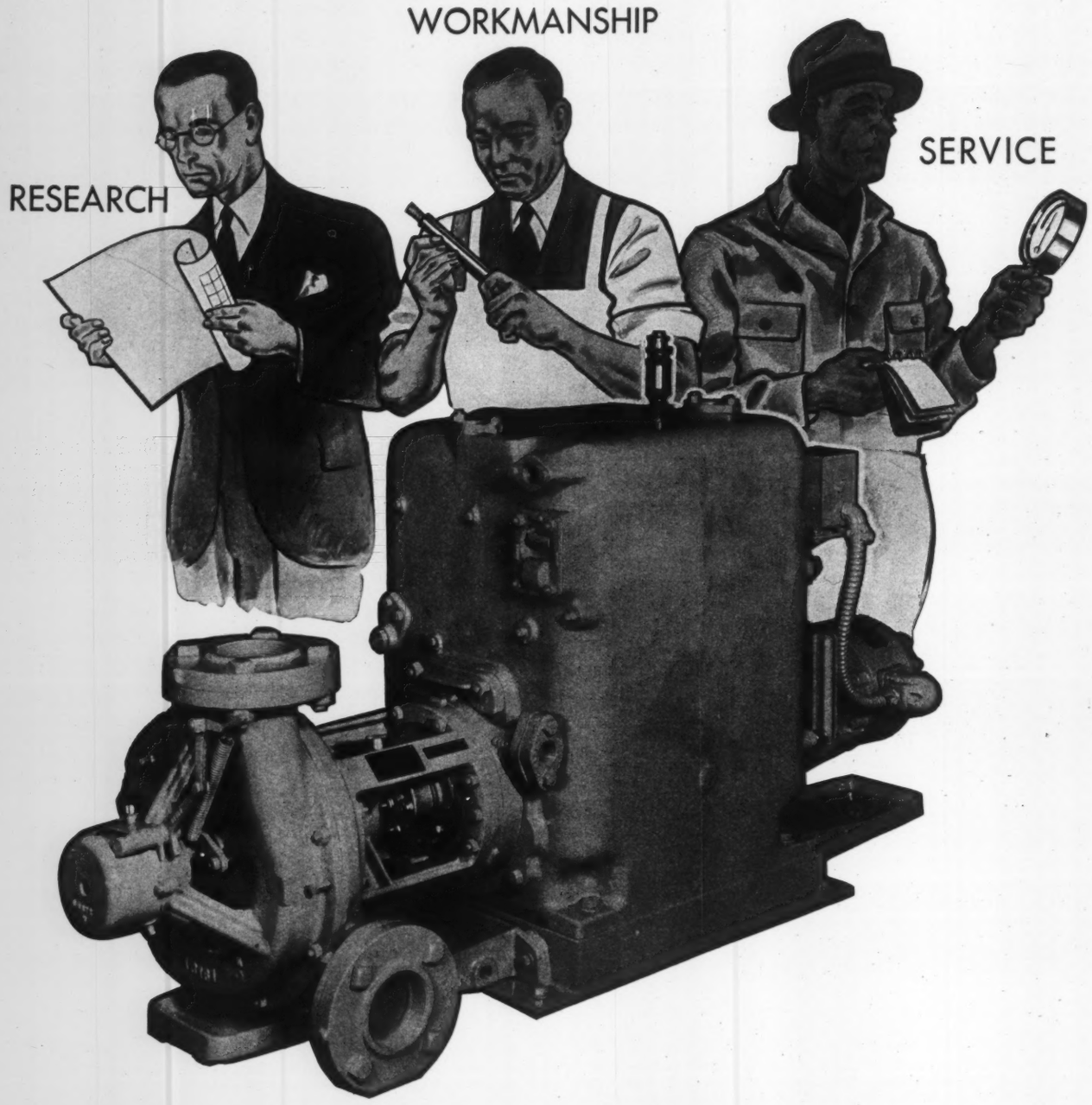

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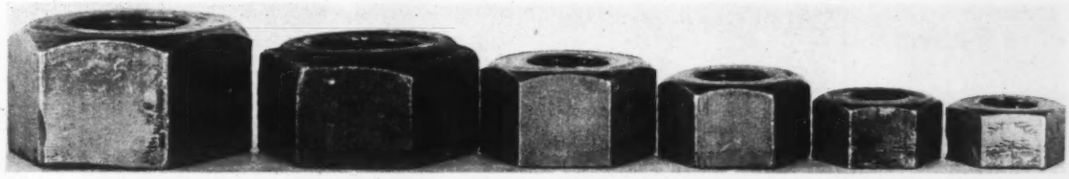
Heating · Piping and Air Conditioning

Vol. 9, No. 3 • *March, 1937*

NUT AND BOLTING MATERIALS

for High Pressure and High Temperature Piping Service



Comparison of corresponding sizes of American standard regular and heavy nuts

Left two—1¼ in., heavy and regular; center two—⅞ in., heavy and regular; right two—⅝ in., heavy and regular.

By **Harvey A. Wagner***

TWO specifications of particular interest to those concerned with piping for high pressures and temperatures have recently been developed by subcommittee XXII of *A.S.T.M.* committtee A1, *i. e.*, specification A193-36T for alloy steel bolting materials for high pressure and high temperature service to 1100 F and specification A194-36T for carbon and alloy steel nuts for bolts for high pressure and high temperature service to 1100 F.

BOLTING MATERIAL

Intelligent selection of a suitable bolting material for high temperature service requires knowledge of the material used, both with regard to its room-temperature physical properties and its properties at the temperature at which the bolts are to operate in actual service.

Design of bolted flange connections should be considered in two steps: (1) Initial compression on the gasket surfaces in making up the joint at room temperature must be sufficient to set the gasket and thereby insure a tight joint when the internal pressure is acting; (2) the high temperature characteristics of the material involved must be such as to maintain a tight joint for as long as the joint is in service.

*Engineer, The Detroit Edison Co., Detroit, Mich.

Success in securing a satisfactory initial gasket compression is directly dependent on the room-temperature physical properties of the bolting material. The prevalent use of metal gaskets in particular requires that sufficient compression be exerted to secure a plastic deformation of the gasket in order to obtain a tight joint without, of course, exceeding the yield point of the bolting material. General practice in the design of flanged joints is to provide sufficient bolt area to give the desired gasket compression without having to stress the bolts beyond about 60,000 lb per sq in. figured at the root of the bolt threads, depending somewhat on the material. The margin between the yield strength of the material and the 60,000 lb per sq in. may be entirely eliminated in warming up the line, due to the additional stress imposed on the bolts resulting from a temperature difference between flanges and bolts. A bolting material possessing high room-temperature physical properties obviously is likely to prove more successful in maintaining a tight joint, provided it also has adequate high temperature properties.

Properties of Steels

Specification A193-36T for alloy steel bolting material lists properties of several steels which are being

Table 1—Chemical Compositions of Several Steels Offered for High Temperature Service[a]

(From *A.S.T.M.* specification A193-36T, *A.S.T.M.* Book of Tentative Standards, p. 108.)

Class	Ferritic Steels								Austenitic Steel
Identification Symbol	B4	B5	B6	B7	B7a	B11	B12	B13	B8
Grade	Nickel Chromium Molybdenum	4 to 6 Per Cent Chromium	13 Per Cent Chromium	Chromium Molybdenum	Chromium High Molybdenum	Tungsten Chromium Vanadium	Chromium Silicon Tungsten	Tungsten Chromium	18 Chromium 8 Nickel
Carbon, per cent	0.35 to 0.45	0.35 max.	0.12 max.	0.35 to 0.45	0.35 to 0.45	0.40 to 0.50	0.40 to 0.60	0.30 to 0.40	0.07 max.
Manganese, per cent	0.50 to 0.80	0.30 to 0.50	0.60 max.	0.60 to 0.90	0.60 to 0.90	0.20 to 0.40	0.20 to 0.60	0.60 to 0.90	0.20 to 0.70
Phosphorus, max., per cent	0.04	0.03	0.03	0.04	0.04	0.04	0.03	0.04	0.03
Sulphur, max., per cent	0.05	0.03	0.03	0.05	0.05	0.04	0.03	0.04	0.03
Silicon, per cent	.....	0.50 max.	0.50 max.	0.15 to 0.25	0.15 to 0.25	0.15 to 0.30	3.00 to 3.50	0.15 to 0.30	0.75 max.
Nickel, per cent	1.50 to 2.00	.....	.....	.....	.....	.....	.....	.....	7.00 to 10.0
Chromium, per cent	0.50 to 0.80	4.00 to 6.00	11.5 to 13.0	0.80 to 1.10	0.80 to 1.10	1.00 to 1.50	8.00 to 10.0	0.45 to 0.75	17.0 to 20.0
Molybdenum, per cent	0.30 to 0.40	0.45 to 0.65[b]	.....	0.15 to 0.25	0.45 to 0.65	.....	.....	0.40 to 0.65	.....
Tungsten, per cent	.....	0.75 to 1.25[b]	.....	.....	.....	1.70 to 2.30	1.25 to 1.75	0.85 to 1.35	.....
Vanadium, per cent	.....	.....	.....	.....	.....	0.20 to 0.30	.....	.....	.....

[a]As these steels are not necessarily all suitable for the full range of temperature up to 1100 F, care should be exercised in making the selection.
[b]Either molybdenum or tungsten shall be used as specified.

used satisfactorily for high temperature service. Table 1, reconstructed from the specification, gives the chemical properties of these materials and Table 2 their respective physical properties at room temperature. Most of the data on these alloys are published in an appendix to the specification for information only until the data can be verified as authentic to the satisfaction of all concerned. Considerable difficulty was experienced in obtaining reliable information on the physical properties of these alloys and the table shown here represents several years' effort. It should be noted that these alloys are not all considered suitable for use at 1100 F, choice depending on design and on the stresses and service for which the material is to be used. The specification also definitely states that other materials may be purchased for high temperature service in accordance with the specification requirements on agreement between purchaser and vendor.

Table 2—Physical Properties for Steels Referred to in Table 1 and Suggested Heat Treatments

(From *A.S.T.M.* specification A193-36T, *A.S.T.M.* Book of Tentative Standards, p. 108)

Note 1.—The data below are for bolts of diameters 2 in. and under. For larger diameters, a suitable reduction in physical properties should be made a matter of agreement between the purchaser and the manufacturer.

Note 2.—These physical properties in Table 2 and the compositions listed in Table 1 are tentative and as such are subject to revision and additions from time to time.

Grade	Tensile Strength, lb per Sq In.	Yield Point, lb per Sq In.	Elongation in 2 in., Per Cent	Reduction of Area, Per Cent	Heat Treatment, Degree Fahr	
					Quench	Draw
B4	170,000	150,000	12	45	1525	1000
	150,000	135,000	15	50	oil quench	1100
	130,000	110,000	16	52		1200
B5	110,000	90,000	12	50	1600	1000
	105,000	85,000	15	52	water	1100
	100,000	80,000	18	55	quench	1200
B6	165,000	140,000	15	55	1750	1000
	125,000	105,000	17	60	oil quench	1100
	105,000	85,000	19	65		1200
B7	160,000	140,000	12	45	1550	1000
	130,000	110,000	15	50	oil quench	1100
	120,000	100,000	18	55		1200
B7a	Physical Properties for Grade B7a to be added later					
B8	80,000	30,000	35	50	Annealed 2000 F water quench	
B11	210,000	190,000	11	35	1750	1000
	205,000	180,000	12	35	oil quench	1100
	185,000	165,000	13	40		1200
B12	190,000	150,000	12	30	1900	1000
	175,000	135,000	15	30	oil quench	1100
						1200
B13	170,000	145,000	13	40	1600	1000
	135,000	115,000	15	45	oil quench	1100
	125,000	105,000	18	52		1200

Identification Symbols

The identification symbols for the alloys listed in Tables 1 and 2 were assigned in correlation with alloys included in similar specifications for forgings, pipe, and castings also developed by subcommittee XXII. It was the desire to designate by the same arabic number the same or similar alloy in all four specifications for high temperature materials, varying only the letter prefix to indicate which of the four alloys was intended. For instance, the 4 to 6 per cent chromium alloy is designated B5 for the bolting specification, F5 for forgings, P5 for pipe, and C5 for castings. Any alloy whose number is 10 or below has a corresponding alloy in at least one other of the four specifications; sometimes, as indicated above, the alloy appears in all four specifications. No alloys B1, B2, B3, etc., appear in the bolting specifications because alloys 1, 2, and 3 are not considered suitable for bolting material. To include an alloy of another composition as B1, for instance, would destroy the significance of the numbering system.

Pending the incorporation of the individual physical properties as given in Table 2 in the text of the specification, two general classes of physical requirements have been set up to cover all the alloys contained in Tables 1 and 2; class D includes the ferritic alloys, class E, the austenitic. Physical property requirements for these two classes are as follows:

Diameter, In.	Tensile Properties	Class D	Class E
2½ and under	Tensile strength, min., lb per sq in.	135,000	80,000
	Yield point, min., lb per sq in.	115,000	35,000
	Elongation in 2 in., min., per cent	15	35
	Reduction of area, min., per cent	45	50
Over 2½ to 4, incl.	Tensile strength, min., lb per sq in.	125,000	80,000
	Yield point, min., lb per sq in.	105,000	35,000
	Elongation in 2 in., min., per cent	15	35
	Reduction of area, min., per cent	45	50
Over 4 to 7, incl.	Tensile strength, min., lb per sq in.	115,000	80,000
	Yield point, min., lb per sq in.	95,000	35,000
	Elongation in 2 in., min., per cent	15	35
	Reduction of area, min., per cent	40	50

When the values shown in Table 2 have been verified, it is the intent to replace in the text the general class D and E requirements with the individual requirements of Table 2.

Performance at Service Temperature

Satisfactory performance of the joint at the service temperature is largely dependent on the creep strength of the material at the elevated temperature. Experience has demonstrated that a much lower gasket compression is required to maintain a tight joint than is necessary to secure an initially tight seal. The important consideration in this phase of the design is, therefore, the long time load carrying ability of the material. Satisfactory design stresses selected on this basis are relatively low, being of the order of 9000 lb per sq in. at 850 F for alloy steel bolting material (*A.S.M.E.* rules for bolted flange connections).

Creep Strength

Setting allowable stresses with reference to the creep strength of the material at elevated temperatures might be termed an art rather than a science, due to the existence of little understood factors which seem to make the material behave inconsistently at high temperatures. The present state of creep information is conflicting and data are difficult to interpret, even when results are considered only from reliable laboratories whose testing technique is known to conform to *A.S.T.M.* requirements, and when creep specimens are used whose history (type of steel, heat treatment, method of manufacture, grain size, and other pertinent data) is known. Two different heats of steel having practically the same composition and heat treated in the same way can exhibit very different creep behavior at elevated temperatures.

Subcommittee XXII of *A.S.T.M.* committee A1 has published creep data on the steels covered by the four specifications for high temperature piping materials developed by that committee. These data are contained in an *A.S.T.M.* pamphlet entitled "Data on Nominal Creep Strength of Steels at Elevated Temperatures." Although information was secured from eleven reputable laboratories, the data are so conflicting and difficult to interpret that the subgroup compiling the information felt unable to assign allowable design stresses to the materials covered. At the moment, it remains largely in the hands of the individual designer to review and analyze the information and then use his best judgment in the selection of an allowable stress based on creep data available.

It should be noted that the high strength bolting materials contained in Tables 1 and 2 are intended for use at high temperatures where flanges and fittings will be made of an alloy steel capable of withstanding the higher stresses imposed by the stronger bolts. Use of the higher strength materials with carbon steel flanges and fittings would be establishing the strength of bolts far beyond the strength of the flange and serious difficulties due to dished flanges would be almost inevitable.

Of particular interest to those concerned with piping for high pressures and temperatures are two new specifications on alloy steel bolting materials and carbon and alloy steel nuts which have been developed by the *American Society for Testing Materials*. . . . The author is thoroughly informed on the work of the subcommittee responsible for the preparation of these specifications, and describes here the requirements they set up and their use, as well as presenting fundamental data on the selection and performance of nut and bolting materials

Threads

The specification requires that all threads be formed after heat treatment. In the case of some materials, such as that designated by B11, for instance, difficulty in threading may be experienced due to the extraordinary hardness of the material. In this case, it may be necessary to thread before heat treatment. As a result of warpage or scale formation, however, threading before heat treatment should provide a sufficient allowance for thread grinding after heat treatment, particularly where close thread fits are desired, such as required to obtain a class 3 fit of *A.S.A.* standard B1. 1-1935 on American standard screw threads.

In the case of both class 2 and class 3 fits, no play whatever exists when the pitch diameters of the mating parts are at their common value; this is shown in Fig. 1. With a minimum bolt and maximum hole, however, applying all the pitch diameter tolerance to both parts, a fit with considerable play is obtained. This is about 70 per cent of that obtained with a class 2 fit, however. For power plant work, it is considered desirable to adhere to the class 3 fit for both nut and bolt.

Other requirements of the bolting specification are substantially the same as in specification A96, which was issued as a tentative specification in 1925 and has served well in the interim.

NUT MATERIAL

Nut material for use with alloy steel bolting material is covered in detail in the first *A.S.T.M.* specification developed specifically for nuts, A194-36T on carbon and alloy steel nuts for bolts for high pressure and high temperature service to 1100 F. Five classes of nut material are covered in the new specification for services varying in degree of severity ranging from class 0 for service under the least exacting conditions to class 3, an alloy nut, for service under the most severe conditions, with classes 1, 2, and 2H for service conditions between these two extremes. Chemical properties for the several grades of nuts are given in Table 3, taken from *A.S.T.M.* specification A194-36T.

As stated in the note given with Table 3, inclusion of the 4 to 6 chrome nut is not intended to preclude use of

Table 3—Chemical Requirements for Carbon Steel Nut Material

	Class 0	Class 1	Classes 2 and 2H	Class 3[a]
Carbon, per cent	0.25 max.	0.25 min.	0.40 min.	0.20 min.
Chromium, per cent	.....	.....	.....	4.0 to 6.0
Molybdenum, per cent[b]	.....	.....	.....	0.45 to 0.65
Tungsten, per cent[b]	.....	.....	.....	0.75 to 1.25
Phosphorus, max., per cent	0.10	0.05	0.05	0.05
Sulphur, max., per cent	0.15	0.05	0.05	0.05

[a]Other types of alloy steel, with their appropriate heat treatments, approved by the purchaser may be submitted under these specifications.
[b]Either molybdenum or tungsten may be used, if desired.

other alloy nuts. While this alloy has been used successfully for nuts in some high temperature applications, other alloy nuts made in accordance with the composition of bolting alloy B11, for instance, have been used with satisfaction. If alloy nuts are used with bolts having the same chemical composition, it has been found advisable to make the nuts differ in hardness from the bolts to prevent sticking, which renders disassembly of a joint very difficult without destroying the bolts.

Nuts of all five classes may be made by the hot forged process, cold punched process, or machined from bar stock. Carbon steel bar stock nuts have not been found satisfactory in piping for higher pressures and temperatures due to their tendency to split when being pulled up to the extent required to maintain tight joints for severe service conditions. The *A.P.I.-A.S.M.E.* code for unfired pressure vessels prohibits the use of carbon steel nuts of nominal size less than 1½ in. machined from bar stock when the axis of the nut is parallel to the direction of rolling of the bar. Bars or nuts of carbon steel which have been properly heat treated would be acceptable, as the heat treatment tends to eliminate the effect of grain orientation produced by rolling.

Checking Physical Properties

Physical properties of the nuts may be checked by means of Brinell hardness tests, a drift test, and a stripping test. Samples of nuts are required to show the Brinell hardness given in Table 4, (1) in the finished condition, (2) after the sample has been subjected for 24 hr to a temperature of 850 F for class 1, 1000 F for classes 2 and 2H, and 1100 F for class 3, and then cooled slowly. The treatment temperatures are indicative of the temperature limitations for each class of nut, although such limits have not been prescribed in the specification.

The drift test is specified as follows: "A conical mandrel, part of which has a diameter equal to the nominal nut size, shall be forced through the tapped hole to the nominal nut size, cold, without cracking the body of the nut. The test may be continued until the nut is broken for examination of the structure." The purpose of the test is to indicate the ability of the nut to withstand splitting. A mandrel for carrying out this test could be made as sketched in Fig. 2, with dimensions to suit the nuts to be tested. The parallel portion after the first rounded section tests the nut against splitting as prescribed in the specification. The mandrel may then be driven further through the nut to split it if desired to examine the metal structure.

The stripping test provides that nuts of classes 1, 2, 2H, and 3 shall be capable of meeting the following: "A nut shall be assembled on a piece of bolting material held in a tension testing machine so that a load is applied to the nut. The threads in the nut shall not strip when subjected to a stress equal to 150,000 lb per sq in. figured at the mean diameter of the bolt." By "mean diameter" is meant the average of the pitch diameter and root diameter of the bolt on which the nut is assembled. This diameter, illustrated in Fig. 1, was chosen rather than the root diameter because tests have demonstrated that ultimate strength figured from the area based on this dimension corresponded most nearly to the strength of the same material when tested with the usual 0.505 *A.S.T.M.* tensile specimen.

Table 4—Brinell Hardness of Nuts

Class	Minimum Brinell Hardness	
	Sample Nut as Finished	Sample Nut After Treatment
0	120	...
1	150	150
2	160	160
2H	250	180
3	250	200

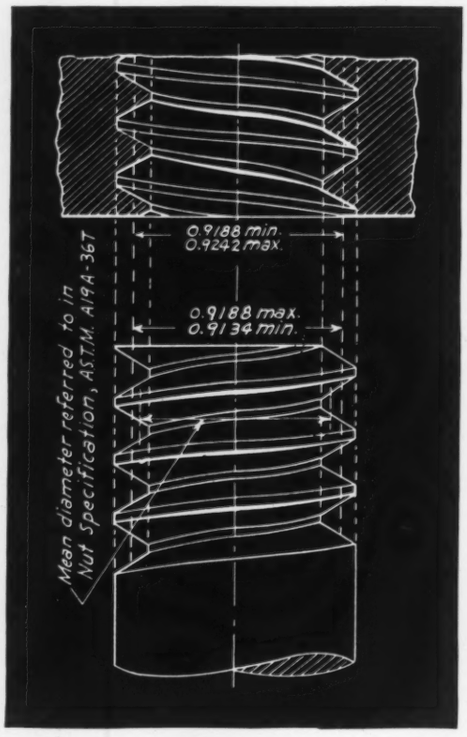


Fig. 1—Pitch diameter for 1 in. bolt and nut, class 3 fit

Note—Four classes of screw-thread fit are provided in American Standard B1.1-1935; Class 1 is the loosest and Class 4 the closest. These four fits are produced by application of specific tolerances or tolerances together with allowances to the basic pitch diameter of the thread which is the same for both internal and external threads of the same size and pitch. Both Class 2 and Class 3 fits represent a high quality of commercial screw-thread product

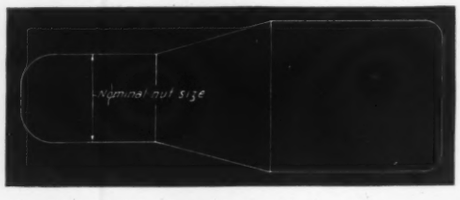


Fig. 2—Mandrel for drift test of nuts

Dimensions

In accordance with customary practice in piping work, the specification requires that nuts for use with American standards for pipe flanges and flanged fittings where the bolt hole is drilled ⅛ in. larger than the bolt diameter used, shall have dimensions in accordance with the heavy series of the American standard for wrench head bolts and nuts and wrench openings, *A.S.A.* B18.2.

Table 5—Identification Marks for Nuts

Class	Hot Forged or Cold Punched	Made from Bar Stock
0	No marking	0
1	1	1B
2	2	2B
2H	2H[a]	2HB[a]
3	3	3B

[a]The letter "H" indicates heat treated nuts.

Past experience has demonstrated conclusively that nuts made to American standard regular dimensions do not possess adequate bearing area when the bolt is shifted to the edge of the bolt hole, as is often the case, and the thickness is not sufficient to provide a satisfactory wrench grip. In order to obtain a tight joint, it is necessary on the larger sizes to sledge up the nuts by means of a maul. This requires the increased thickness of the heavy nuts to provide a secure wrench grip and to insure sufficient threads to develop the strength of the bolt. The photograph reproduced on the title page illustrates the pronounced difference in dimensions between the American standard regular and American standard heavy nuts.

Threads in accordance with American standard coarse thread series are required, except that nuts of sizes 1⅛ in. and larger for use with American standard steel flanged fittings and companion flanges, *A.S.A.* B16e, are to be provided with threads in accordance with the American standard 8 pitch thread series, *A.S.A.* B1.1. The greater number of threads per inch involved in use of the 8 pitch thread series has been found necessary to provide sufficient mechanical advantage to pull up a joint tight. Even when using these threads, it is necessary to sledge up the joint to make it pressure tight in service.

Identifying Marks

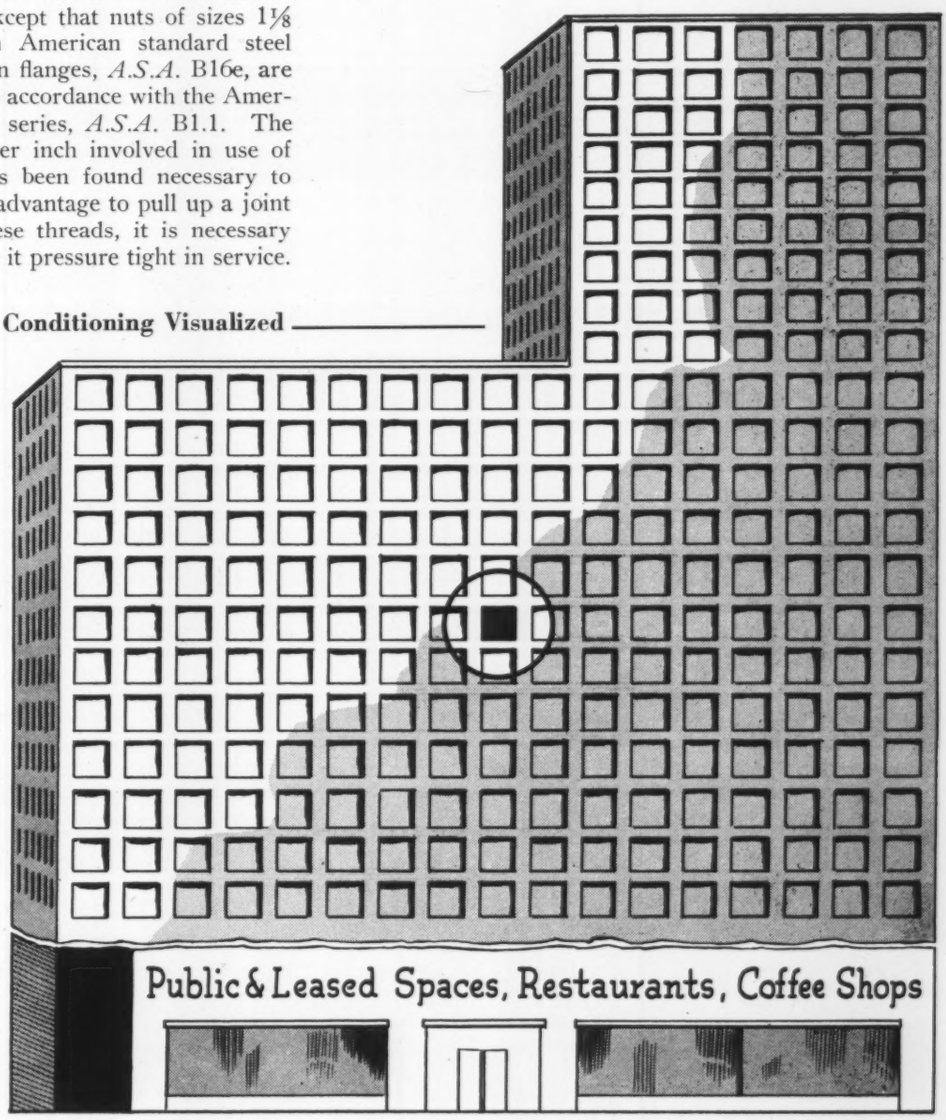
Another important innovation in the specification requires that all nuts shall contain an identifying mark to indicate the manufacturer, and that the grade and process of manufacture be indicated by the stamped marks as shown in Table 5.

With the exception of class 0 hot forged or cold punched nuts, which the manufacturers considered impractical to mark, the class of nut, method of manufacture, and manufacturer may be readily ascertainable from identification marks on every nut.

Specifications of Material Assistance

These two specifications have been developed after several years' intensive effort by the subcommittee. While many revisions will no doubt be required, the present specifications will be of material assistance in the purchase of these commodities for high pressure and high temperature piping which is being fabricated for service in the near future as well as for replacements for present piping now operating at elevated temperatures and pressures.

Hotel Air Conditioning Visualized



Each window represents 4000 rooms, the 267 windows of the diagram representing about 1,000,000 rooms in U. S. hotels containing over 100 guest rooms, which may be expected to represent the total potential market for guest room air conditioning in the United States, according to "Air Conditioning Trends," from which this illustration is reproduced. The black window in the circle represents the 4000 (approximate) guest rooms that are now conditioned

The blacked-in portion of the lower part of the diagram, given over to restaurants, bars, coffee shops, etc., represents all such conditioned spaces in hotels of 50 rooms or more, while this entire part of the diagram—of which the blacked-in part is about 10 per cent—represents the number of such spaces in hotels of this size

New Charts Simplify Splitter Design

By R. D. Madison*

Purpose of this article is to summarize the data originally given in "Pressure Losses in Rectangular Elbows," by R. D. Madison and J. R. Parker, published in HEATING, PIPING AND AIR CONDITIONING, July-August-September, 1936, and to offer further observations on the use of the data in the design of duct systems. . . . A new chart that simplifies the location of splitters in elbows to reduce pressure loss is presented

WHILE it is generally well known that long radius elbows are of the "low loss" type, it is not so well appreciated that elbows of shorter radius can often be made equal to them or better in performance with the aid of one or two simple splitters.

Although the use of the term "radius ratio" has been generally adopted for designating the degree or abruptness of bend in 90 deg elbows, the author and J. R. Parker have sought to introduce a new term to simplify elbow calculations.[1] Formerly, if the center line radius (average of the inside and outside radii) was divided by the width of the duct in the plane of the bend the radius ratio would be obtained. Our curves have been plotted upon "curve ratio," a term used to mean the inside radius divided by the outside radius. Since both radii are known, the curve ratio value is easily obtained.

In the original paper[1], a method of finding the elbow loss with various numbers of splitters was given. To simplify this solution and at the same time give a visible indication of the number of splitters desirable, Fig. 1 has been prepared. While the curves are strictly for elbows of square cross section, they may be used for other cross sections approximating these dimensions.

Assume we have an elbow with an inside radius of 2 in. and an outside radius of 20 in., the curve ratio is 2 divided by 20, or 0.1. Referring to Fig. 1 for a curve ratio of 0.1, an elbow with no splitters will have a loss of 60 per cent of the velocity pressure in it. If this same elbow were to have one splitter, the loss would be 22 per cent as indicated by the lower curve. Whether two or three splitters should be used in this elbow depends partly upon how important it is to reduce the loss to a minimum. Seldom would it be necessary to use more than three and if the curve ratio of the original elbow is large, less might even be better than more, as indicated by the crossing of the curves.

In the original article a chart[2] was given for the suggested ideal location for splitters in elbows. Further study of the law upon which this chart is based suggests a simpler and more direct method. Such a revised chart is shown in Fig. 2. The scale at the left represents the actual inside radius of an elbow while that on the right represents the outside radius. By laying a straight edge across these two points the intersections with the vertical scales between them locate the radii to be used for one, two or three splitters depending upon the number used. All scales are graduated alike.

Thus, as indicated in the example, if an elbow has an inside radius of 2 in. and an outside radius of 20 in. and there are to be two splitters, connect these two points with a straight line. Where this line crosses the vertical one marked "No. 1 of 2," read 4¼ in., the radius of the smaller splitter, and where it crosses the line marked "No. 2 of 2," read 9¼ in., the radius of the larger splitter. If three splitters were to be used the corresponding radii can be read directly from the intersection with the three scales marked "No. 1 of 3," "No. 2 of 3" and "No. 3 of 3." The radius of the center splitter is exactly the same as if only one were used.

While it is generally well known that 1½ center line radius elbows (elbows having a center line radius 1½ times the width of the duct) are of low loss type, it is frequently found that due to cost of fabrication or expediency on the job inferior elbow construction is used. The first important thing to keep in mind is that if one has to cut corners it should be on the shorter runs. The longest ducts should be favored by lowering the frictional resistance in them so that the equivalent of a shorter system may be obtained. This may be done by proportioning the size of duct to lower the velocity in it the farther it carries the air. All elbows in these longer runs should be of the low loss type. If the center line radius cannot be made as large as 1½ times the duct width, splitters may be used as previously explained.

Even a small inside radius instead of a sharp corner will materially cut down elbow loss as shown by the curves in the original paper.

The pressure loss of an elbow is not greatly affected by size. If, therefore, one is accustomed to figure an elbow as an equivalent length of straight duct that method is permissible as long as the radius ratio of the elbow is known. The usual low loss elbow of 1½ center line radius has a loss equivalent to a length of 8 to 10 diameters of duct.

Although no tests were made with velocities below 1800 fpm, it is reasonable to believe (from tests at higher velocity) that the loss (in velocity heads) at 900 to 1000 fpm will be about 10 per cent higher than those recorded in this paper. That is, if an elbow from the chart shows a loss of 20 per cent velocity head, based on 1800 fpm, it will have approximately 22 per cent velocity head at 900 fpm.

One interesting observation resulting from the tests is that for ducts of square cross-section the amount of material forming the flat sides of the elbow exactly equals that of the curved sides. This leads to the following equation for the total surface of any rectangular elbow

$$A = \pi R\ (a + b)$$

where A = total square feet of material
R = center line radius of the elbow (average of inside and outside radii), ft
a and b = sides of the duct, ft
$\pi = 3.1416 =$ approx. 22/7.

To this value of A must be added a percentage for seams and flanges depending upon the type of construction.

*Research Engineer, Buffalo Forge Co., Buffalo, N. Y.

[1]See "Pressure Losses in Rectangular Elbows," HEATING, PIPING AND AIR CONDITIONING, July-August September, 1936.

[2]Reproduced from "Fan Engineering," 3rd edition, 1933, published by Buffalo Forge Co.

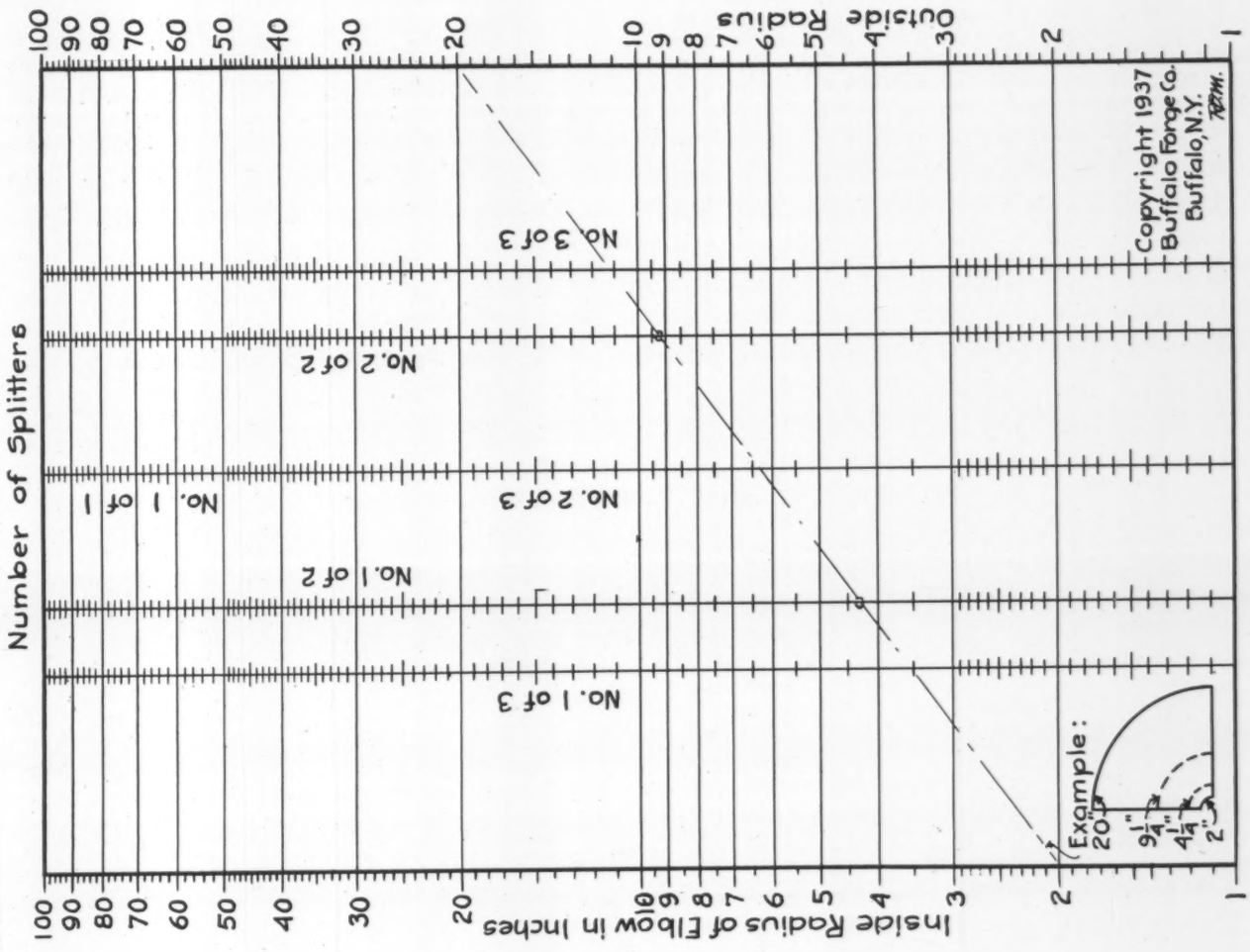


Fig. 2—Chart giving radii of elbow splitters

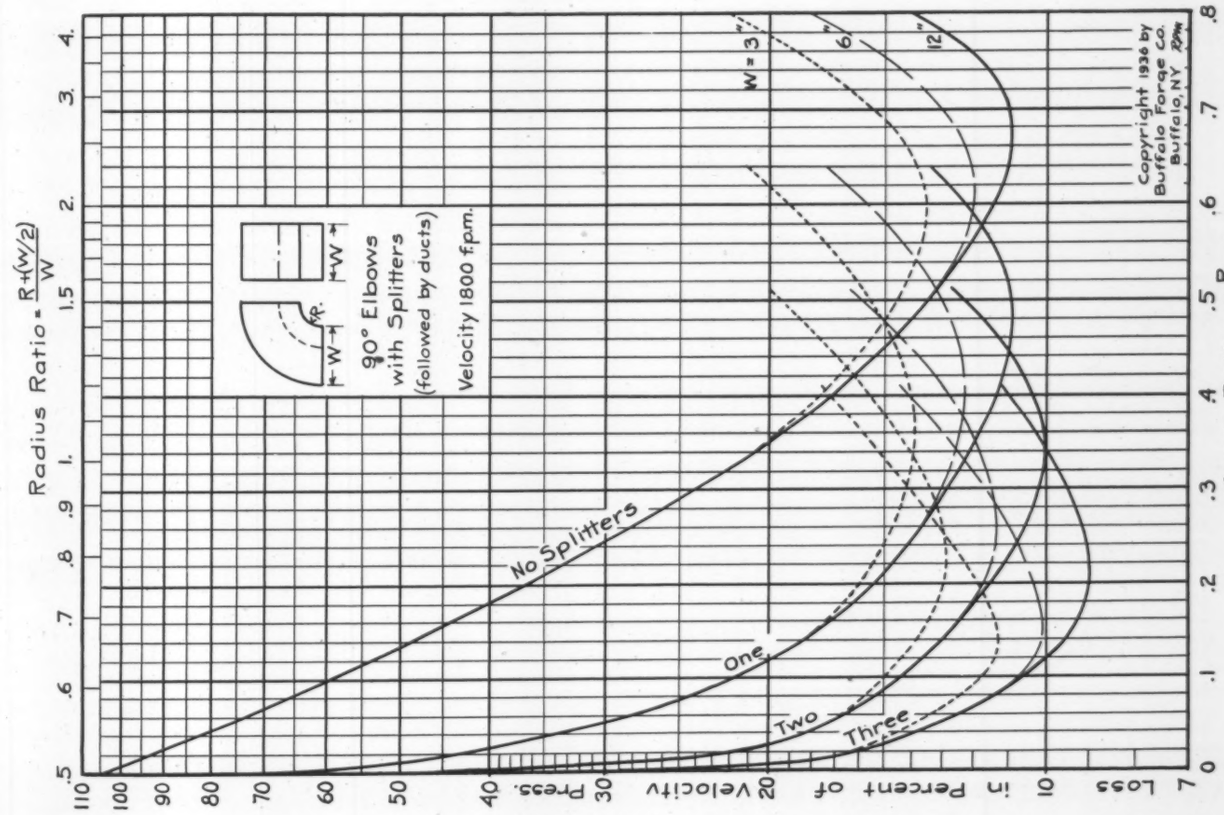
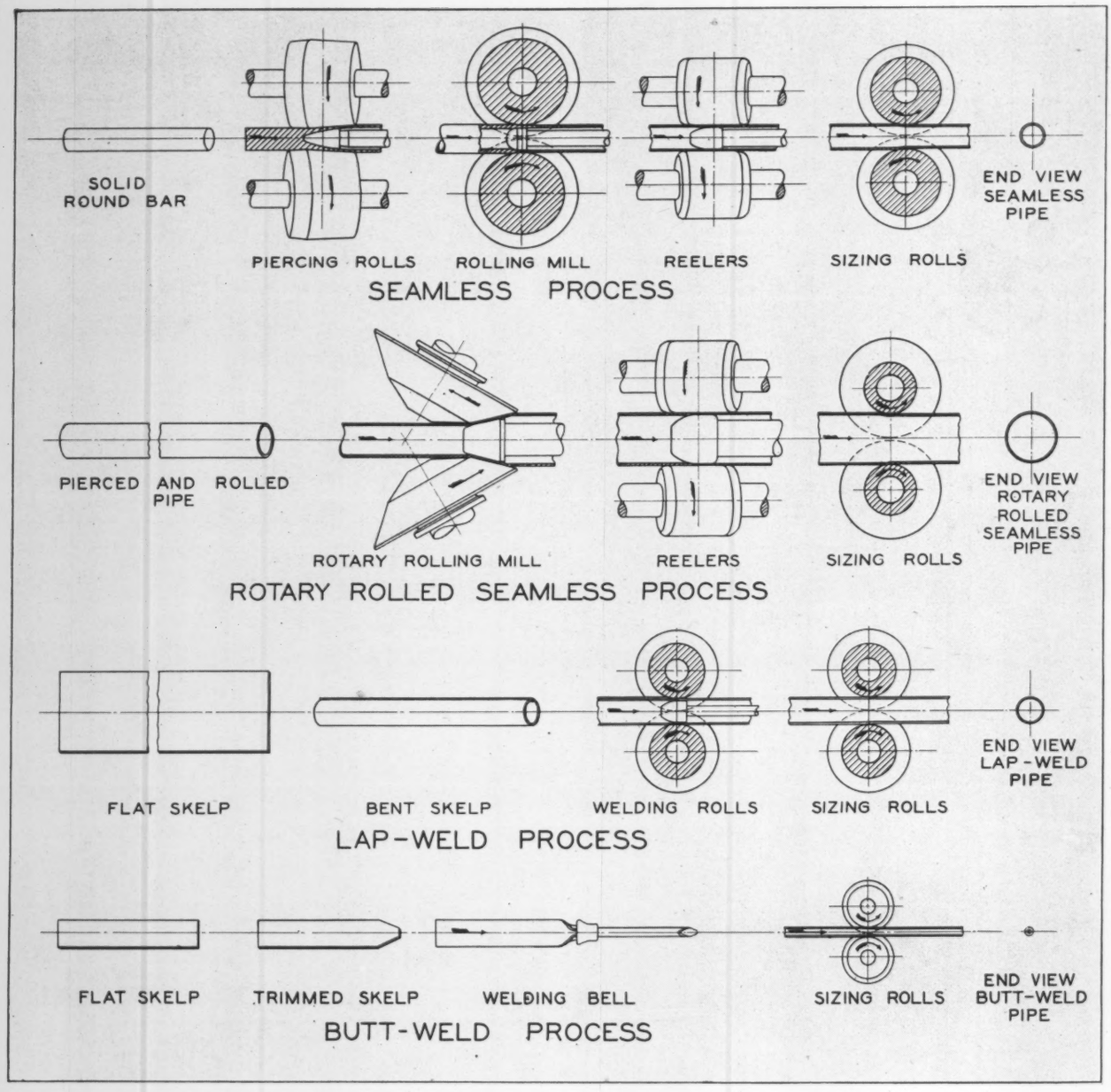


Fig. 1—Pressure loss in elbows with splitters



How Pipe Is Made

SPEAKING in broad terms, pipe in present day use is either welded or seamless. Welded pipe is known by terms indicating the method of welding employed—butt weld, lap weld, hammer weld, electric weld, etc.

Butt weld pipe has the edges of the strip of metal from which the pipe is formed simply butted together and their junction welded. The process is to heat flat strips of metal, of a length suitable for the finished length of the pipe, to welding temperature, and then to draw the strip through a funnel shaped opening in a die called the welding bell. In the funnel shaped passage, the flat strip is bent into tubular form with the edges butting together. The round opening in the welding bell is of a size to cause pressure on the butted edges and thus effect the welding of the edges.

Lap weld pipe is rolled to tubular form before heating to welding temperature. The edges of the plate are beveled and overlap when the plate is formed to a tube. The welding heat is applied to the overlapped edges, and the pipe is then entered in a circular groove formed by two rolls. A cylindrical welding ball is held in position in the groove, and the tube, passing through the rolls and over the ball, has pressure applied to the over-

[*Concluded on page* 169]

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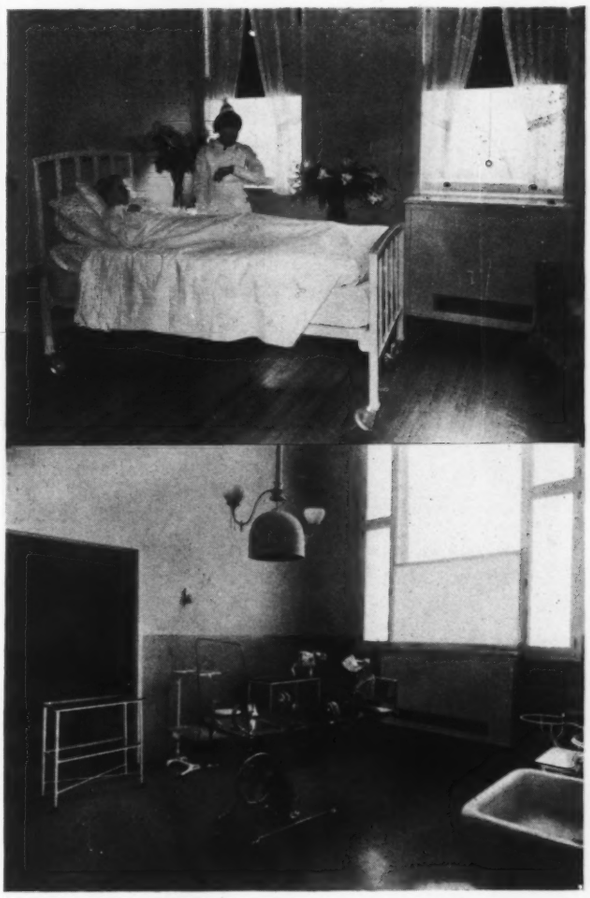
Hospital Air Conditioning System Maintains Low Relative Humidities

By A. J. Lawless*



An air conditioned private room above, and air conditioned operating room below. Local recirculating units of the injector type are used

THE Corey Hill hospital, Brookline, Mass., is completely air conditioned; all 50 bedrooms, operating rooms, solariums and corridors are cooled, dehumidified and ventilated in summer and heated, humidified and ventilated in winter. This has been done not only for the comfort of the patients but also for medical observation of the effect of air conditioning on certain diseases, such as asthma, hay fever, arthritis and other rheumatic ailments.

It has been established that the condition of patients suffering from arthritis or other rheumatic fevers has been improved by living in climates where low summer relative humidities prevail. The main function of this air conditioning system, therefore, is to produce a continuous relative humidity condition as is obtained only intermittently in the proper localities.[1]

The Design Requirements

The installation had to be approached from a slightly different angle than is the usual all year comfort job because of the following requirements:

General recirculation was not to be allowed. Even though some hospital authorities are of the opinion that recirculation to the amount of 50 per cent is not objectionable in hospitals where contagious diseases are not handled, it was felt that the psychological effect of recirculated air on patients should be considered.

A much lower relative humidity during summer operation was required than is usually necessary for comfort conditions. Relative humidities between 30 and 35 per cent were to be maintained.

Because of the no recirculation requirement, an all outside air system had to be used and an exact balance had to be obtained between the amount of air required for ventilation, the maintenance of a pressure for the prevention of infiltration of air or vapor, and the air required to remove the sensible heat load due to people, lights, a maximum of 12 deg transmission, and sun effect. Before starting calculations it could be assumed, as is so in most air conditioning installations, that the air required for the removal of sensible heat at a proper temperature rise would exceed the ventilation air requirements.

Because of this, the first step was to do everything possible (within economic reason) to increase the insulating value of exposed surfaces and to make the building air-tight. All windows and doors were double sashed and either weatherstripped or closed tight and caulked where possible. This was a large item because a veranda around three sides allows for a door opening from practically every room. All inside doors such as openings to the attic, basement, and elevator shaft were also weatherstripped.

*Sales Engineer, The Cooling & Air Conditioning Corp., Div. of B. F. Sturtevant Co., Boston, Mass.

[1]For further information on the reasons for air conditioning this hospital, see the report of the meeting of the Air Conditioning Bureau of Boston, HEATING, PIPING AND AIR CONDITIONING, January, 1937, pp. 21 and 47.

Corey Hill Hospital
Brookline, Mass.
Schematic Drawing of Air Conditioning System

In making the first calculations it was determined that a 20 minute air change within the net conditioned area was the absolute minimum. This is slightly above normal but, in addition to maintaining pressure, sufficient air had to be provided to offset positive exhaust systems from the diet kitchens, operating rooms, and baths. The kitchens and baths are not directly supplied with conditioned air. Even after all these precautions were taken into account, it was still considered advisable to deliver the air to the conditioned area at a dewpoint temperature approximately 10 deg below the maintained dewpoint so as to take into account the internal moisture gains and those due to evaporation from outside exposed surfaces.

It may appear that considerably more stress was given to this point than necessary, but this is because infiltration in the usual air conditioning system is considered more from the standpoint of increased sensible heat load rather than increased relative humidity during the cooling and dehumidifying season. Where a relatively low differential between the outside and inside dewpoint temperatures is maintained, a little infiltration does not seriously affect the inside maintained relative humidity. In this case, if as little as a 90 minute air change had been allowed as infiltration, a 7 per cent increase in relative humidity would have occurred under extreme outside conditions. Thus, it can be seen that infiltration was of prime importance and had to be eliminated to obtain proper operation.

Because lower-than-usual relative humidities were necessary and no general recirculation could be permitted, the design requirements for the complete air conditioning of the Corey Hill hospital presented problems different from the usual comfort conditioning installation. . . . They were met by a system combining dehumidification by absorption, with lithium chloride as the absorbent, and mechanical refrigeration for sensible cooling. . . This unusually clear explanation of the problem and its solution describes the design of the air conditioning system and—more important—tells why this particular method was adopted. . . . It proves again that an air conditioning installation is an engineering problem, that each job must be designed for its particular requirements

The Scheme of Air Distribution

In obtaining the heat balance between the determined air volume and sensible heat gains, it was found that air would have to be delivered during the summer under extreme conditions at a temperature approximately 30 deg below the maintained temperature. This temperature could not be increased by the usual methods of bypass with either outside or recirculated air because, as stated, general recirculation was not allowed, and an outside air bypass would upset the relative humidity control. An arbitrary increase in outside air through the contactor would have increased both initial and operating costs. Local means therefore had to be provided to introduce this air at this abnormally low temperature without producing drafts and other defects usually caused by extreme differences between maintained and delivered air temperatures. In order to do this, it was decided to use local recirculating units of the air injector type; these units had previously been designed and used successfully for the purpose of reducing the general air supply and recirculation to a minimum in several large government office buildings in Washington.

The unit consists of a primary air outlet approximately 30 in. long by ½ in. wide through which air from the central system is supplied to the unit at sufficiently high velocity so as to have the capacity to inject 130 cfm of recirculated air for every 100 cfm of primary air. With this method of local recirculation it is possible to provide air through the supply grille at only a 13 deg differential under maximum cooling conditions. The unit also contains a fin type heater in the recirculating air duct under the control of a self contained steam valve for maintaining proper temperatures during winter operation.

The next step was to determine if the distribution system could be economica.ly installed in the building and to decide on the type of equipment which would furnish air to the units at the required temperatures. It is sometimes necessary for the designing engineer to deviate from the system which he considers ideal, in order to meet local requirements, particularly so in installing a system in an existing building. In this particular case, however, it was found that the ideal system could be installed.

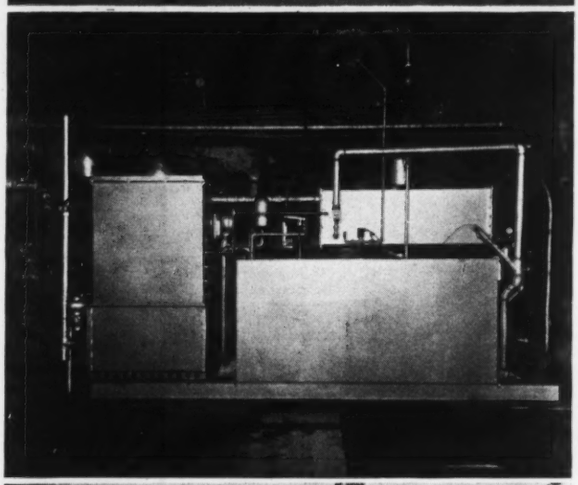
The building is three stories high and of a T shape with the flange of the T much longer than the stem. It was built at two different intervals, the original section comprising one-half the flange and the stem, with a later addition of the other half of the flange. The newer section, consisting only of bedrooms with private baths, had been heated by direct radiation with positive exhaust from the baths. In this section the new system was installed by replacing the direct radiation with the units and running new supply ducts up the outside corners of the rooms with horizontal take-offs for the units. The original section contains the diet kitchens, public baths, operating rooms, solariums and bedrooms, mostly without private baths. This section had been heated by old type gravity stack heaters located in the sub-basement with individual ducts along the inside walls to each room, each room also having a gravity exhaust duct to the roof. In addition to providing the units and new supply ducts, a complete new heating system was installed and spaces not directly supplied with conditioned air were furnished with direct radiation. In both cases the exhaust systems were properly dampered and left intact.

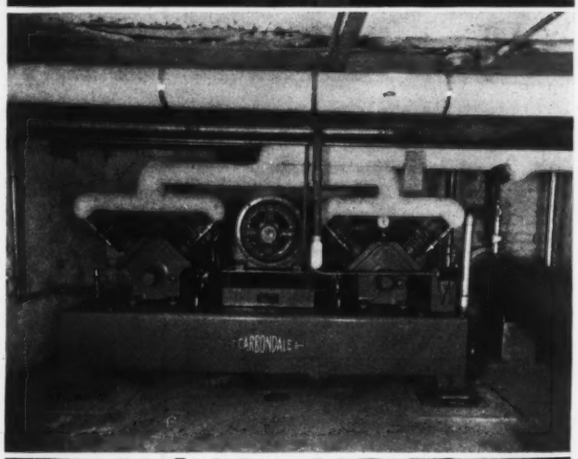
The Central Conditioning Plant

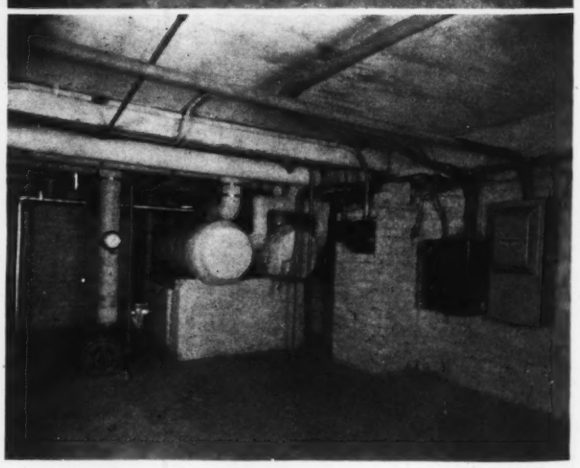
The central conditioning plant had to be capable of delivering air to the recirculating units (under maximum cooling and dehumidifying) at 40 deg dewpoint and 50 deg dry bulb. Under less than full load, this air must be delivered at the same dewpoint with the dry bulb varying above 50 deg as determined by the sensible heat load.

After studying several methods which would meet the requirements, it was determined that a combination absorption and mechanical refrigerating system would be the most economical. The moisture is first removed by passing the air through the absorbing medium and then the sensible temperature is decreased by refrigeration. A complete mechanical refrigerating system showed a fairly high operating efficiency under full load conditions, but under less than full load sensible heat requirements it would have been necessary to reheat the air by steam or other means before it was furnished to the units.

The absorption system uses a solution of lithium chloride as the contact medium and operates on the principle of vapor flow caused by differences of vapor pressure. Air at 40 deg dewpoint has a vapor pressure of 0.1217 lb per sq in. If this air is brought into proper







TOP TO BOTTOM

Air heaters and lithium chloride contactor. . . . Close-up of lithium chloride sump tank, concentrator, condenser, and supply pump. . . . The mechanical refrigeration machine for sensible cooling, and part of the lithium chloride solution cooler. . . . The water coolers, water pump, and chilled water storage tank

contact with any other fluid having a lower vapor pressure, there will be a flow of vapor from the air to the fluid. If the contact were 100 per cent efficient, this flow would continue until equilibrium of vapor pressures was reached.

In all salt solutions, the vapor pressure is a function of both concentration and temperature; an increased concentration at constant temperature or a decreased temperature at constant concentration effects a decreased vapor pressure. Either one or both of these methods for reducing the vapor pressure of the solution can be used in order to obtain proper dehumidification. In this particular installation both methods are used; concentration is obtained by boiling and cooling is obtained by 70 F city water, furnishing the solution to the contactor under maximum dehumidification requirements at a density of 1.270 and a temperature of 75 deg.

Because of this relatively high density it is impossible to use the usual spray type contactor. The contactor is of rectangular shape, 10 ft long, through which the air passes at a 300 fpm velocity. Contact is made by means of specially prepared vertical cotton strings placed on ½ in. centers, both crosswise and lengthwise, down which the solution flows by gravity from a tank type header on the top of the contactor. This method provides the necessary solution surface and contact period for the proper flow of vapor. Eliminators for preventing the passage of entrained solution are installed in the air-leaving end of the contactor.

Operation of the Dehumidifier

During the dehumidifying season the relatively weak solution leaving the contactor flows by gravity to a sump tank. From the sump tank a local recirculation is provided between the sump tank, the combination economizer and condenser and a gas-fired boiler type concentrator by which a small portion of the total solution is highly concentrated and returned to the sump tank. The

vapor from the concentrator passes through the economizer where partial condensation is obtained from the cool solution supply to the boiler and further condensation of this vapor is obtained in the condenser by city water under the control of the condensate temperature.

The gas valve at the concentrator is under the control of the second step of a three step controller regulated from the general humidistat in the conditioned area. As the relative humidity increases, the gas valve opens, increasing the concentration of the solution and if, in the meantime, the humidistat has not been satisfied, the density increases to the predetermined maximum and is maintained at that point by the density controller operating the gas valve. The concentrated solution from the sump is then pumped through a shell and tube type cooler, the city water to which is under the control of a thermostat in the air leaving the contactor.

By this combined method of effecting a reduced vapor pressure of the solution, it is possible, under extreme absorption load when the outside temperature is 88 deg dry bulb and 69 deg dewpoint, to obtain from the contactor a 40 deg dewpoint with a maximum of 86 deg dry bulb.

Inversely, during the humidifying season, the solution vapor pressure is increased by weakening the solution and providing the necessary heat. Under this operation, the local recirculation through the concentrator is closed and steam is supplied to the sump under the automatic control of the first step on the step controller; this produces the necessary deconcentration of the solution. Steam is used rather than water because of its purity and the latent heat obtained from its condensation. The additional heat as required is provided by two sections of air heaters on the entering side of the contactor, the first section under the control of the outside air thermostat and the second section under the control of the supply air thermostat, maintaining a delivered air temperature of 72 deg.

Three Zones for Control

The building, because of its T shape and orientation, with the flange of the T running directly east and west, was divided into three zones of summer temperature control, having north, south and east, and south and west exposures.

The air, after leaving the contactor, is forced by the main supply fan through three sections of fin type coolers, where it is cooled by refrigerated water, the flow of which to each section is regulated by the zone thermostats. This water is pumped from a central storage tank through the air coolers and then through shell and tube type water coolers back to the storage tank. Cooling is accomplished in the water coolers by direct expansion of "Freon" under the control of a thermostat shutting off the "Freon" supply, which, in turn, causes decrease in back pressure on the compressor, shutting off the compressor.

The refrigeration condenser is in series with and after the solution cooler. Under normal conditions of operation the condenser will receive more than enough water for condensing purposes but inasmuch as this supply is controlled from the absorption system, an auxiliary water supply is provided to the condenser under the control of the compressor high pressure valve.

The refrigeration system is designed for a maximum outside temperature of 92 deg and with 75 deg wet bulb as a datum point, an increased load on the absorption system because of higher than outside designed dewpoint temperature concurrently decreases the load on the refrigeration system. In order to take advantage of this excess capacity in the refrigeration, a crossover connection is provided between the refrigerated water system and the city water supply to the solution cooler. The automatic valve in this connection is under the control of the third step of the step controller. This additional cooling of the solution further reduces its vapor pressure, increasing the capacity of the absorption system.

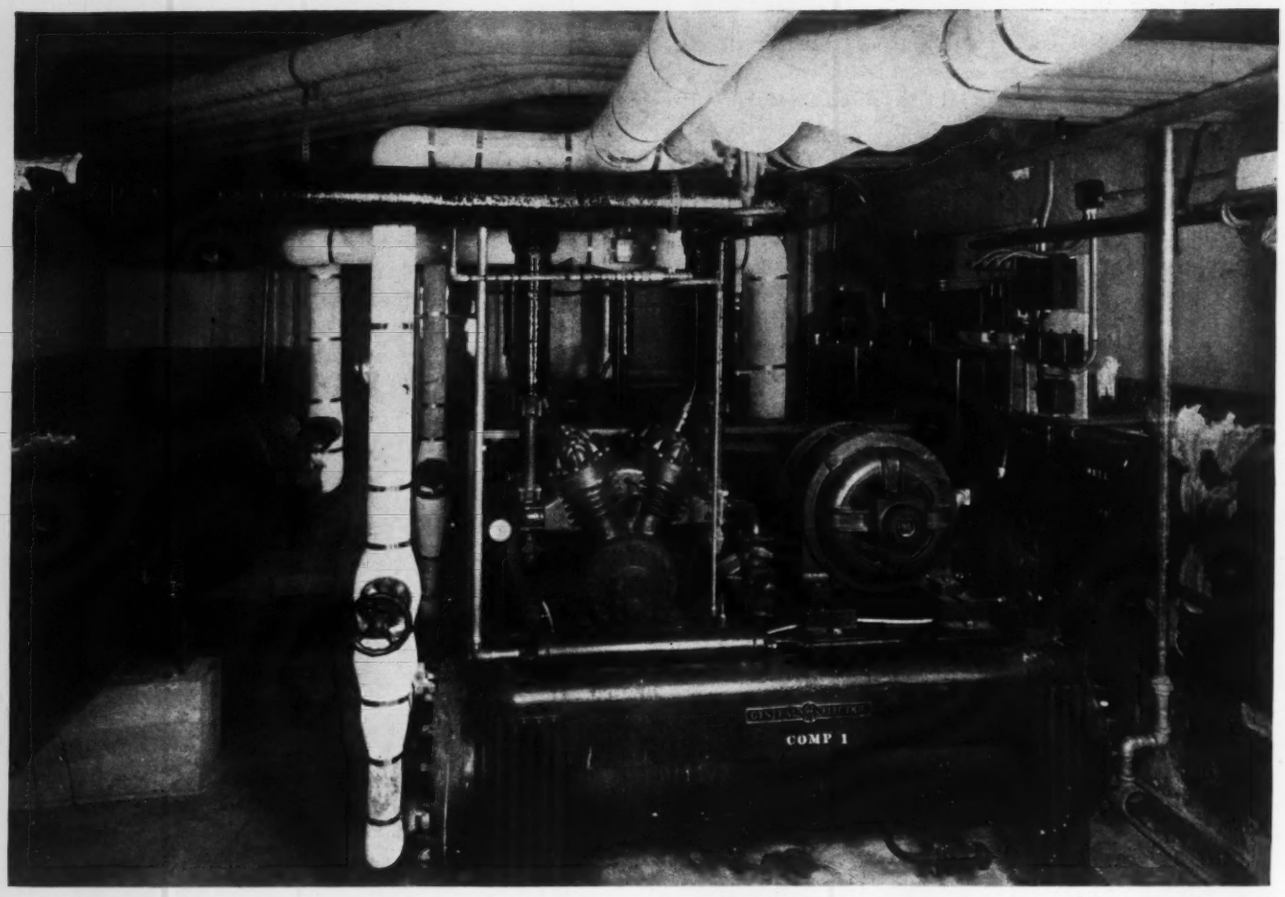
Advantages of the Method

Under extreme conditions of operation, 60 per cent of the total work is accomplished by the absorption system and, under these conditions, there is required 38 cu ft per hr of 540 Btu per cu ft gas and 2.5 gpm of city water per ton of refrigeration developed. This indicates a saving in operating cost of approximately 20 per cent over mechanical refrigeration. There is not only this saving in operating cost because of mechanical efficiency of the equipment but a larger saving is accomplished by the thermodynamic efficiency of the absorption system where reheating is not required under less than full load conditions.

Although not of utmost importance in this particular installation, where all outside air is used, lithium chloride, in addition to having moisture absorption properties, has the property of absorbing from the air soluble gases, smoke, odors, bacteria and other objectionable impurities to a greater extent than water or other means of contact.

It is the writer's opinion that, even though the installation cost of most such absorption systems is higher than that of mechanical refrigeration, the increased cost often can be more than offset in savings in operating cost, particularly so when the latent heat load is a large proportion of the total heat load.

The Corey Hill hospital, with a capacity of 50 to 60 beds



The two 40 hp condensing units and the 80 hp shell and tube water cooler in the basement machinery room of the Harrington

Here's Complete Data on

A Large Hotel Air Conditioning Job

EARLY in 1936, the Harrington Hotel, in downtown Washington, D. C., decided to air condition about 200 of its 300 guest and sample rooms. The management adopted a policy of not increasing rates for air conditioned rooms, and it was consequently of the utmost importance to design a system which would be low in first cost and economical in operation. To meet these requirements, a system using a combination of well water and mechanical refrigeration was selected. In considering the cost figures on this particular installation, it should be kept in mind that they represent "depression values" and it is doubtful if a job like this could be done at present for less than an increase of 25 per cent.

The Harrington is a fireproof structure of steel, brick, and concrete. One part of the building consists of a ground floor, mezzanine, and five bedroom floors, while the remainder of the building is higher, having five additional bedroom floors.

The original plan called for the air conditioning of 200 rooms, or in other words, all rooms on the mezzanine and first five bedroom floors of the entire building. This is an area of 73,600 sq ft.

Before the completion of the installation, the management decided to air condition all rooms on the sixth, seventh, and eighth floors, thus adding 60 rooms, which brought the total number of air conditioned rooms up to 260, 40 of which are large sample rooms. The area was thus increased to 92,350 sq ft.

Design Conditions and Construction Characteristics

The design for the summer air conditioning system was based on the following conditions with load reducing equipment described:

Time of peak load—3:00 p. m.

Outside conditions—95 F dry bulb and 78 F wet bulb or 48 per cent relative humidity

By John B. Hewett*

The management of the Hotel Harrington decided last year to air condition, did a thorough job. Here is the complete story—written by the engineer responsible for the design—describing not only the details of the installation, the equipment used, its control and operation, but presenting as well information on installed cost, cost of operation and depreciation. . . . The system is an indirect central plant type, with the field fabricated air conditioner on a penthouse roof supplied with chilled water from the water cooling equipment in a basement machinery room; the water cooling equipment consists of two 40 hp condensing units, direct expansion shell and tube water cooler and a 150 gpm well supplying cold water

Inside conditions—80 F dry bulb and 66.7 F wet bulb or 50 per cent relative humidity

Occupant load—1½ people per guest room, 3 people per sample room

Lighting load—150 watts in north and east rooms, 400 to 600 watts in each sample room

In the original design, the ventilation air was selected to provide 2.8 changes per hour for the rooms to be air conditioned. The addition of the sixth to eighth floors inclusive of the high building reduced the outside air changes to approximately 2.2 per hour, ample to satisfy requirements, making it unnecessary to provide additional ventilation air to the system.

Outside Shades and Insulation Reduce Heat Gain

To reduce the heat gain, outside shades were installed on the east and west windows; 4 in. of rock wool placed over the ceiling of the low building; and the air space above ventilated. Because a portion of the exposed roof of the low building is shaded from 3:00 p. m. on, the installation of the rock wool and ventilation of the attic reduced the heat gain only by approximately 3¼ tons, whereas the installation of the outside shades on the west side of the building reduced the heat gain 7½ tons. The insulation and window shades gave a comparatively small reduction in required refrigeration capacity on the basis of initial capital expenditure, but greater benefit is derived from the reduced operating cost because the east shades and roof insulation reflect in the consumption preceding 3:00 p. m.

The shades are composed of narrow wood web strips woven together by specially treated threads and have not been used previously for this purpose in the District of Columbia. These shades are slightly more expensive than the regular awnings but in addition to serving the same purpose, they are more weatherproof, and it is expected that they will have a much greater life than the ordinary awning.

System of Indirect Central Type

The system installed is of the indirect central plant type utilizing a field fabricated air conditioner with remote water cooling equipment. The air conditioner, situated on the penthouse roof of the five story building, consists of a variable vortex fan driven by a 20 hp motor through a V belt drive, water cooling coils, spray humidifier, eliminators and dry steel wool filters for both recirculated and ventilation air.

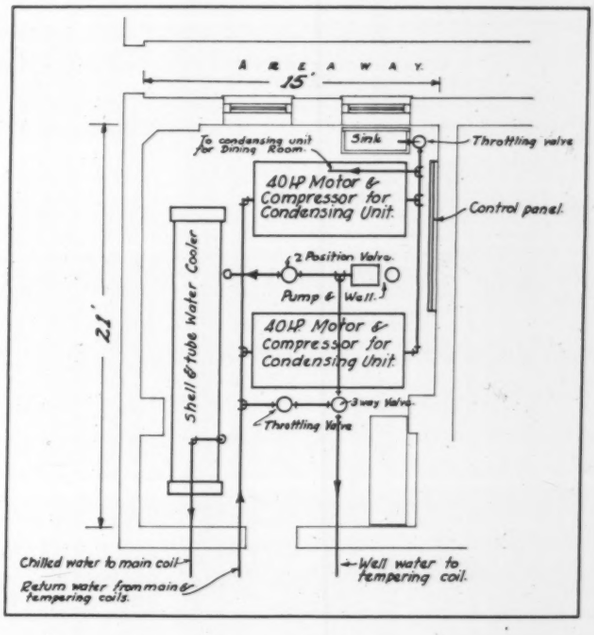
The water cooling equipment includes a 6 in. impeller pump which is driven by a 15 hp motor; one 80 ton, 14 ft by 30 in. diameter, two circuit, direct expansion, shell and tube water cooler; two 8 cylinder V type compressors driven through V belt drives by two 40 hp motors; and a well producing 150 gpm of 65.5 F water.

The well, which has a total depth of 83 ft below the basement floor was drilled in a basement room approximately 15 x 21 ft with a 10 ft ceiling height located 15 ft below street level. This room serves as a machinery room for the water cooling equipment. To obtain full advantage of all water bearing strata, a total of 23 ft slot, welded, copper silicon screen was installed. A three-day test on the well gave a continuous maximum delivery of 210 gpm of water at 63 F with a water level at a depth of 63 ft below the basement floor. With constant operation of the well, the level of the water has been found to be 60 ft and the maximum temperature 65.5 F. Therefore, it is estimated that the well is stable and that it will continue to deliver the 150 gpm of water which now is being pumped from it.

Operation of the System

During mild weather, for example in the spring and fall when neither heating nor cooling is required for the hotel, dampers automatically controlled by compensated thermostats and humidistats permit the fan to handle full capacity of outside air when this will provide comfort conditions within the conditioned area. This device, which is essentially an economizing control, permits the removal of all the equipment except the fan from operation during mild weather and results in an appreciable reduction in the operating cost of the system.

Schematic diagram of water cooling equipment



*Engineering Manager, Hudson Air Conditioning Corp., Washington, D. C.

Summer Air Conditioning

Should either the outside temperature and/or humidity become sufficiently high to result in an effective temperature above the comfort zone within the building, the ventilation air is automatically reduced to 15,000 cfm for which the system is designed, and the well pump is placed in operation to circulate water through the coils in the conditioner. A slightly higher temperature within the building will cause one of the 40 hp condensing units to be automatically placed in operation to provide 50 per cent of the refrigeration capacity available. Should the inside effective temperature increase further to exceed comfort conditions, the second 40 hp condensing unit is automatically placed in operation so that the full refrigeration capacity is available.

The thermostat and humidistat in the recirculated air stream and connected to compensating outdoor thermostats and humidistats maintain the desired inside conditions. The outdoor-indoor differential controls provide for a reduction of indoor temperature and humidity below the inside design conditions when the outdoor dry bulb is low and the relative humidity is high, thus giving comfort conditions within the building for wide variations of outside conditions. Further, a humidistat and limiting dry bulb controller set at 78 F are connected to a three way modulating valve in the water supply line to a tempering coil to bypass a portion of this water directly to the condensers of the refrigerating machine, thus providing an amount of reheating by reducing sensible heat reduction of the recirculated air as required under design conditions.

Zoned Control—Originally it was felt that zoning would be required for the east and west exposures of the hotel to allow for variations in sun effect throughout the day. It was found, however, that with the allowance of 150 watts of lighting for each room on the shaded portion of the building, this amount substantially offset the sun effect and zoning was eliminated from the system. Zone control of hotel rooms when the halls are used for return air, as was done in this case, is not practicable because the thermostat for the individual zone cannot be located in the conditioned area nor can control be obtained by the location of the thermostat in the hall, since removing a portion of the rooms from the system changes the condition of the return air, thereby necessitating readjustment of the thermostat.

Winter Air Conditioning

For winter air conditioning, the system does not include the basic heating load of the hotel which is handled by the existing direct radiation system. The only heat required is that necessary to temper the outside air supplied to the building for ventilation purposes and the amount of this air is automatically reduced, as the outside temperature drops, to a minimum of 5000 cfm at 0 F. This air is tempered by the well water and moisture is added by the spray type humidifier.

Due to the method of air distribution in the individual rooms, with the air supplied at 65 F, it is felt that no drafts will be perceptible, and the excess direct radiation installed in the building supplies the additional heat required to raise the temperature to comfort conditions. During the night, it is the intent to supply air between 50 and 60 deg to the rooms, simulating as nearly as possible conditions resulting if the windows were open. Not only does this provide a more comfortable and cleaner condition for the occupants of the rooms, but the majority of the heat supplied to the radiation system may be cut off during the night hours. Also, it is not necessary to raise the temperature of the room from the outside temperature to comfort conditions the following morning, which should effect an appreciable reduction in the heating cost during the winter months. A certain amount of experimentation will be conducted with this arrangement and it is believed that the guests will be more satisfied with the conditioned air supplied in this manner than that obtained by opening the windows which is accompanied by street noises, soot and dirt.

The air treating equipment, supplied with chilled water from the basement machinery room, is on the penthouse roof of the five story part of the building

Installed Cost of Air Conditioning

The total cost of the entire air conditioning system, including the well, for the 220 guest rooms and 40 sample rooms was in the vicinity of $42,000, of which the refrigeration equipment was approximately 25 per cent of this amount. This gives a cost of approximately $150 per room, or approximately 40c per sq ft of conditioned space. It is estimated that the use of the well water reduced the first cost of the system $15,000, which amounts to a resultant saving of approximately 16c per sq ft of conditioned space. The refrigeration equipment installed was somewhat in excess of that required when used with the well; therefore, the cost of the refrigeration equipment included in the above figure is slightly in excess of the amount required for the installation.

Cost of Operation and Depreciation

It was originally estimated that the total power consumption of the air conditioning system for the five months cooling season of Washington, D. C., would be in the vicinity of 190,000 kwhr; and at an average cost of eight mills per kwhr based on seven mills per kwhr plus the demand charge, this would give a total cost for the summer cooling season of $1520. The management has found that this estimate was approximately correct.

for the power cost for the first four months of the past cooling season was in the vicinity of $1250, approximately $1.20 per month per room for the first four months of the summer cooling season.

The estimate for winter operation has been based on the fan operating 24 hr each day except during four months of the season when it will be shut off during peak power loads, reducing the operation period to 20 out of the 24 hr. It has been estimated that the pump will operate approximately 2000 hr during the winter air conditioning season, and the total consumption of the fan and pump will be in the vicinity of 100,000 kwhr. Based on an average cost of 9½ mills per kwhr, the total operating cost for the fan and pump throughout the winter air conditioning season will be $950.

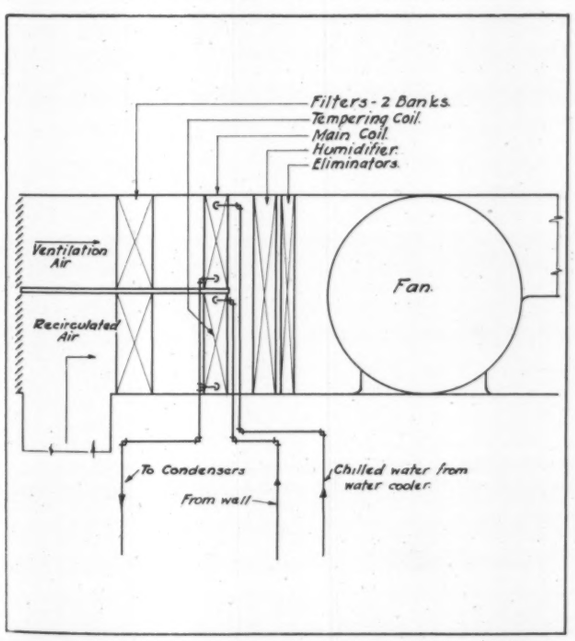
This gives a total estimated operating cost for the year of $2470 or approximately $10 per room per year.

The fixed charges of the system, including depreciation of equipment, service, repairs, insurance, taxes, etc., have been estimated to be $2390 per year or approximately $9.20 per room per year. Therefore, the total cost of the system, including the fixed charges and operating costs, will be $4860 per year.

Operating Results

Early during the cooling season, the hotel management expressed the desire to lower the inside temperatures below design conditions, and as a result the air conditioned rooms were maintained at 78 F and 50 per cent relative humidity throughout the majority of the season. Tests conducted on the system on July 9, 1936, which included readings taken in several parts of the building, when the system was operating under approximately design conditions, gave the maximum variation within the conditioned rooms of 1 deg plus or minus dry bulb and 2 per cent plus or minus relative humidity, with the controls set to maintain 78 F dry bulb and 50 per cent relative humidity.

Schematic diagram of air conditioner



The maximum demand of the air conditioning equipment during the past cooling season was 81 kw, of which it is estimated that 13 kw was fan load, 10 kw pump load, and the remainder was compressor load. As is evidenced by the demand, the two compressors operate at reduced speed, and as stated before, were selected over-sized because it was desired to have sufficient capacity to air condition at least the five floors and mezzanines of the two buildings should the present delivery of the well decrease due to unpredictable causes. If the machines were operated at normal speed and the present delivery of the well maintained, with certain modifications of the system, it is quite practicable for the hotel management to condition the remainder of the hotel with the present refrigeration equipment.

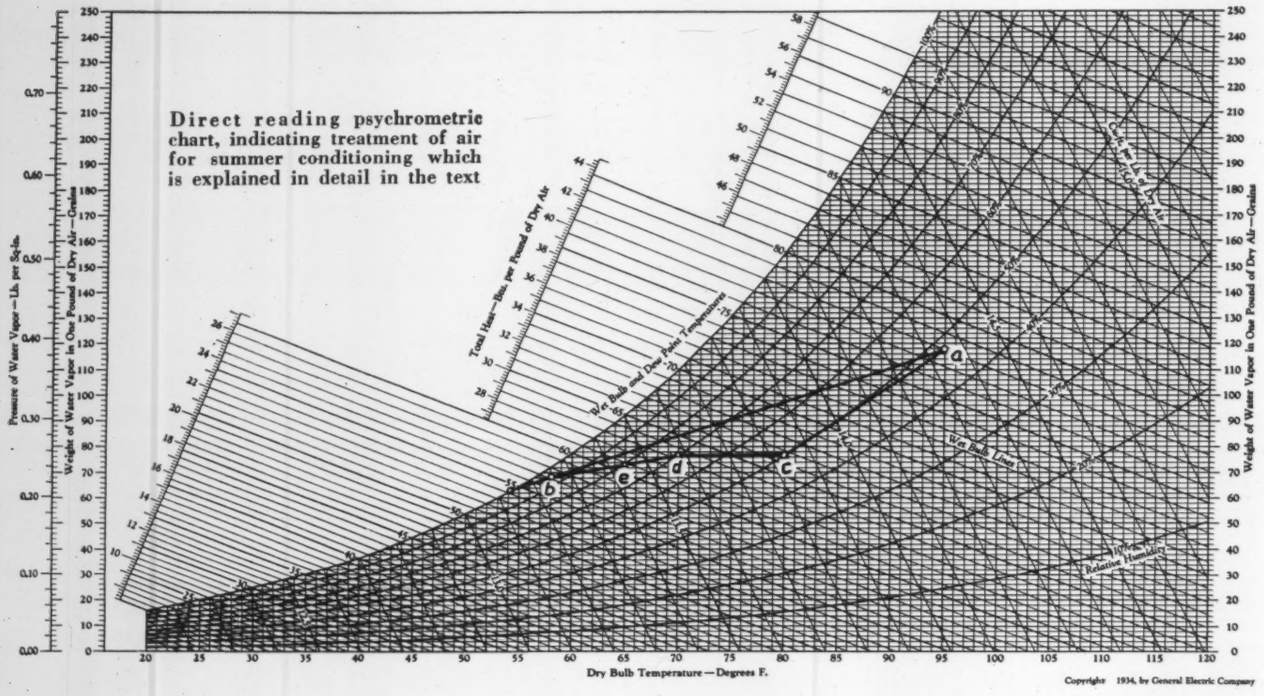
Details of the Design

Summer Air Conditioning System

The conditioner was designed to handle a total of 30,000 cfm of air which would provide a temperature difference of 16 F between the air supplied to, and the temperature maintained within, the conditioned area. To utilize economically the well water, two individual cooling coils were installed in the conditioner, one in the ventilation air stream and one in the recirculated air stream. A total of 150 gpm of water is delivered from the well, 60 gpm of which is delivered directly to the tempering coil in the recirculated air stream and 90 gpm through the water cooler to the main coil in the ventilation air stream.

The total heat load of the system, including the mezzanine and first to fifth floors of the low and high buildings, is approximately 47 tons, of which 5 tons is latent heat. Due to the high percentage of sensible heat in this load, it is possible to remove the additional 5 tons of latent heat from the ventilation air and remove only sensible heat from the recirculated air. The 15,000 cfm of ventilation air equals a load of 60 tons and this added to the internal load of the building gives a total load of 107 tons. The addition of the sixth to eighth floors without increasing the ventilation air gives a total increase of approximately 13 tons, or a total load of 120 tons for the system. This additional load includes the internal load calculated on the same basis used in the design of the original system but without an increase in the total ventilation air supplied.

The refrigeration load as originally designed was to include 49 tons of mechanical refrigeration and the remaining 58 tons was to be removed by the well water. On this basis, the water supplied from the well at 65 F was to be reduced to 50 F in the water cooler, at which temperature it entered the main coils and left at a temperature of 76 F. The well water supplied to the tempering coil removed sensible heat only from the return air and left this coil at 69 F. On this basis, the water from the main and tempering coils was returned through a single riser at approximately 74 F to the condensers of the two 40 hp refrigerating machines. A portion of the water which left the condensers at approximately 86 F was then to be used to cool the refrigerating machine connected to the dining room air conditioning system, which was formerly cooled by city water, and the remainder discharged directly to waste.


Direct reading psychrometric chart, indicating treatment of air for summer conditioning which is explained in detail in the text
Dry Bulb Temperature — Degrees F.
Copyright 1934, by General Electric Company

Psychrometric Chart and Design of Cooling Coils

The basis of the design of the air conditioner was simplified by the use of the direct reading psychrometric chart reproduced here, which indicates the treatment of the air for summer air conditioning as it passes through the conditioner by means of the points plotted thereon. The design of the cooling coils for summer operation shown on the chart was based on the original load of 107 tons.

As indicated on the chart, ventilation air enters the main coil at 95 F dry bulb and 78 F wet bulb (a) and the total heat as read from the chart is 41.5 Btu per lb of dry air. Fifty deg water enters the coil which was arranged for counterflow cooling, and the air is cooled on a straight line to 58 F dry bulb and 57 F wet bulb (b) where the total heat is read as 24.5 Btu per lb of dry air. Fifty per cent of the total air circulated or 15,000 cfm based on 13.5 cu ft per lb of dry air, the approximate specific volume of the air handled by the fan, gives a total of 66,700 lb per hr of dry air passing through the main coil. The amount of sensible and latent heat removed from this air is 17 Btu per lb of dry air, the difference in the total heat readings at (a) and (b) or a total of 1,133,000 Btu per hr.

Recirculated air enters the tempering coil at 80 F dry bulb and 66.7 F wet bulb (c) and the total heat as read from the chart is 31.3 Btu per lb of dry air. 63.5 F water enters this coil which was also arranged for counterflow cooling and the air is cooled on a horizontal line with constant water vapor to 70 F dry bulb and 63.2 F wet bulb (d) where the total heat as read on the chart is 29 Btu per lb of dry air. Thus the heat removed by this coil is 2.3 Btu per lb of dry air or a total of 148,700 Btu per hr, and the addition of this to the heat removed from the main coil gives a total of 1,281,700 Btu, or approximately 107 tons, the calculated load for the 180 guest rooms and 40 sample rooms under design conditions.

The ventilation air is 50 per cent of the total air circulated. Therefore, the mixture of the air from the two coils is half-way between points (b) and (d). The internal latent heat load is 3 grains per lb of dry air circulated. Therefore, this amount of moisture was removed from the ventilation air in addition to the reduction from outside design conditions, at which point the air contained 118 grains per lb of dry air, to inside conditions at which point the moisture content was 77 grains per lb of dry air. The moisture content of the resultant air mixture is actually 73 grains per lb of dry air, or 4 grains below the inside conditions, 1 grain lower than that required.

In the selection of the actual water temperature supplied to the coils, allowance was made in the refrigeration capacity to reduce the water below 50 F to provide a reduction in moisture content greater than required by design conditions. This compensated for infiltration which was expected to enter into the recirculated air as a result of the use of the halls and stair-well for the return of the air from the conditioned areas.

Air Distribution

In the design of the air distribution system low velocities were maintained through the ducts to avoid the possibility of noise and the necessity of sound insulation. The air from the fan is delivered at approximately 1500 fpm through a main riser centrally located in the hotel and passing through Room 32 on each of the five floors of the old building. From this riser the main distribution ducts on each floor extend along both sides of the hall at the ceiling and are connected by short branches

[*Concluded on page* 173]

How to Solve Heat Transfer Problems

Part 3—Counterflow

By William Goodman*

PROBLEMS involving counterflow heaters and coolers are the most confusing to solve; their solution is considerably simplified by the use of Table 1. A sketch similar to Fig. 6, with all known temperatures indicated, is also of help in solving any such problem.

Counterflow problems are handled in exactly the same manner as those for parallel flow, except that, for counterflow only,

$$M = \frac{UA}{Gs}\left(1 - \frac{Gs}{G's'}\right) \quad \text{.....[4]}$$

where

U = Coefficient of heat transmission, Btu per hr per deg temp. diff. per sq ft of surface
A = Area of heat transfer, sq ft
G = Weight of warm fluid, lb per hr
s = Specific heat of warm fluid
G' = Weight of cool fluid, lb per hr
s' = Specific heat of cool fluid
(See Table 1 for M.)

The only difference between Formulas 3 and 4 is in the sign before the ratio $\frac{Gs}{G's'}$; the sign is minus for counterflow and plus for parallel flow.

Unlike the problems heretofore presented, problems in counterflow divide into three types depending upon the value of the ratio $\frac{Gs}{G's'}$ which will henceforth, for convenience sake, be designated by the symbol N. Thus, in all subsequent discussions:

$$N = \frac{Gs}{G's'} \quad \text{.....[5]}$$

The three types of counterflow problems are:

1. When N is less than one.
2. When N is equal to one.
3. When N is greater than one.

When N is less than one, the curves representing the temperature of the two fluids at any point in their travel past the heat transfer surface are as indicated by Fig. 6. Notice in particular that the final temperature of the warm fluid tends to approach the initial temperature of the colder fluid.

When N is equal to one, the curves representing the temperature of the two fluids are as indicated by Fig. 7. In this one case, the curves become two parallel straight lines, and the temperature difference is the same at all points on the surface. The initial, final and mean temperature differences are all equal to each other.

When N is greater than one, the curves representing the temperature of the two fluids are as indicated by Fig. 8. Notice that in this case the curvature of the two curves is opposite to those in Fig. 6. More interesting still, notice that in this case, the final temperature of the colder fluid tends to approach the initial temperature of the warmer fluid.

The moral to be drawn from a comparison of Figs. 6 and 8 is clear. In designing surface to cool air—as an example,—if the final temperature of the air is to be brought as close to the initial water temperature as possible, the value of N should be less than one. On the other hand, when air is being heated by warm water—if the final air temperature is to brought as close as possible to the initial temperature of the warm water—the value of N should be greater than one.

An advantage of using Table 1 is that even in counterflow problems, when only the initial temperatures of the warm and cold fluids entering a surface of a given area are known, it is quite easy to find the final temperature of both. However, before proceeding to problems of this type, it will be best again to solve one problem utilizing Formula 1.[1]

Example 10 (Class 1): Take the conditions of Example 7[2], and find the required area of heat transfer surface if a counterflow heater is used.

Solution: Referring to Fig. 8, (contrast this with Fig. 5),

$D_L = 150 - 60 = 90$ deg
$D_s = 180 - 110 = 70$ deg

$$\frac{D_s}{D_L} = \frac{70}{90} = 0.78$$

From Table 1,

$$\frac{D_m}{D_L} = 0.886$$

$D_m = 0.886 \times 90 = 79.7$ deg

From Example 7,

$H = 650{,}000$ Btu per hr
$H = A \times U \times D_m$

$$A = \frac{H}{U \times D_m}$$

Heat transfer problems of practically every class are met in heating, piping and air conditioning work. While research is adding to our knowledge of heat transmission coefficients, there seems to be—in general—lack of knowledge of how to use such data in computing the performance of various types of equipment. . . . It is to fill the need for this information that these articles have been prepared, their object being to present simple methods for solving such problems, particularly the more troublesome ones dealing with counter-flow. . . . In Part 1 (January issue) the classes of heat transfer problems were outlined, the solution of problems involving condensing or vaporizing fluids was explained, and a table compiled by the author, which simplifies computations, was presented. . . . Parallel flow was the subject of Part 2 (February). . . . Problems in counterflow, the most difficult to solve, are explained this month.

*The Trane Co., LaCrosse, Wis. Member of Board of Consulting and Contributing Editors. Copyright, 1937, by William Goodman.

[1] See Part 1, HEATING, PIPING AND AIR CONDITIONING, January, 1937, pp. 11-14.

[2] *Example 7:* An air supply of 12,000 cfm is to be heated from 60 to 110 deg with water at an initial temperature of 180 deg. The final temperature of the water is to be 150 deg. The value of U for the heater is 14 Btu.

Illustrating, for counterflow, the temperature changes which occur in both fluids as they flow past the heat transfer surface. Symbols with prime marks always refer to the cool fluid, and those without to the warm fluid

$$N = \frac{G\,s}{G'\,s'}$$

where G = weight of warm fluid; s = specific heat of warm fluid; G' = weight of cool fluid; and s' = specific heat of cool fluid

Fig. 6—When N is less than one

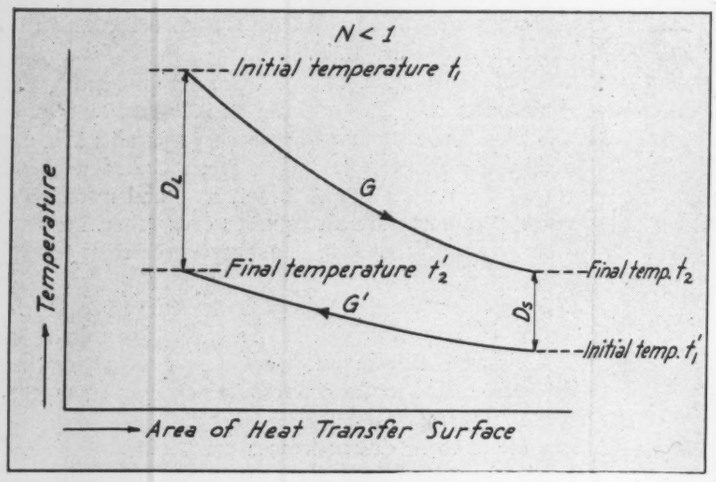


Fig. 7—When N is equal to one

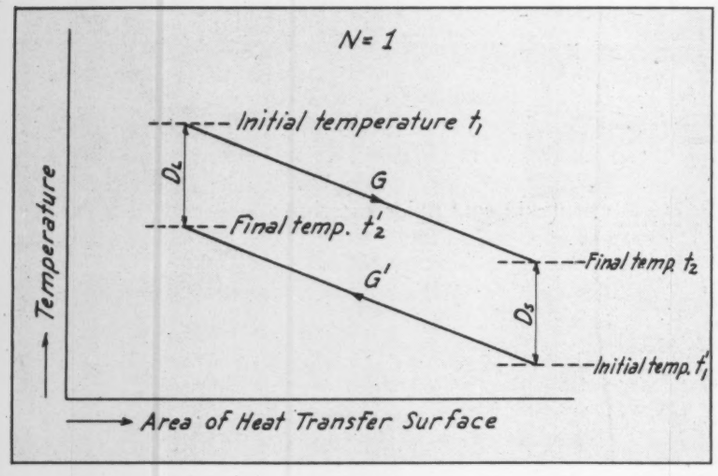
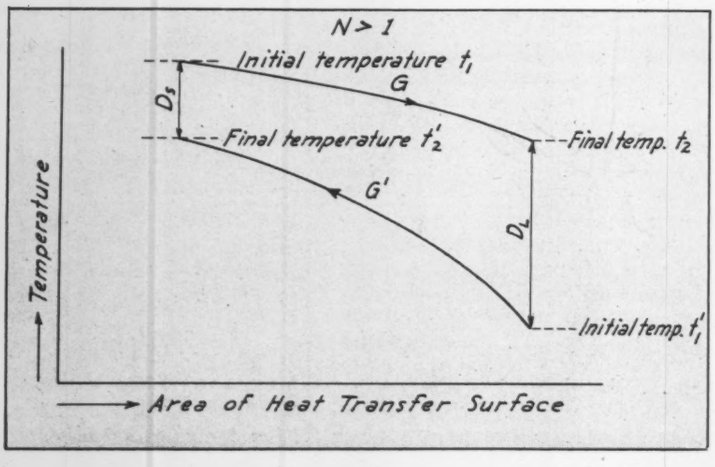


Fig. 8—When N is greater than one



$$= \frac{650{,}000}{14 \times 79.7} = 582 \text{ sq ft of surface}$$

Compare this answer with the 640 sq ft of surface required when parallel flow is used for the same set of conditions. Any surface of a given area will transfer more heat if the flow of the two fluids is counter rather than parallel, because a greater temperature difference can be obtained between the two fluids at all points on the surface.

A problem that frequently occurs is that of finding the quantity of heat which a given coil can remove from the air flowing through it when only the initial temperatures and the weights of the flowing air and water are known. Once the total heat transferred from the air to the water is known, it is a relatively simple matter to compute the final temperature of either the air or the water. Under these conditions, the following formula can be used to compute the total heat H (Btu per hr) transferred from a warm to a cold fluid in counterflow.

$$H = \frac{L\ (t_1 - t_1')}{1 + \dfrac{L}{U\ A\ F}} \qquad [6]$$

(The derivation of this formula is given in the appendix.)

where all symbols are as heretofore, and

t_1 = Initial temperature of the warm fluid.

t_1' = Initial temperature of the cold fluid.

$$F = \frac{D_m}{D_L}$$

L = Either Gs or $G's'$; whichever one of the two is larger.

The first step in using Formula 6 is to find the value of M by means of Formula 4 for counterflow. Then the corresponding value of $\dfrac{D_m}{D_L}$ can be obtained from the second column of Table 1. This will be the value of F which is required in order to solve Formula 6.

A word of caution is needed in regard to L in Formula 6. The symbol L represents the numerical value of either Gs or $G's'$ depending upon which of the two is the larger. The *larger* of the two values should *always* be substituted for L.

When $\dfrac{Gs}{G's'} = 1$, there is no problem in regard to the numerical value of L since $Gs = G's'$. Also under these conditions, $F = 1$. With these precautions in mind, a few actual examples will best illustrate the method of using Table 1 and Formulas 4 and 6 for counterflow problems.

Example 11 (Classes 2 and 3): A coil used to cool air has an area of 1575 sq ft. The value of U is 12 Btu. An air quantity of 9000 cfm, having an initial temperature of 95 deg, is to be cooled with water having an initial temperature of 57 deg. Only sensible heat is removed from the air. The quantity of water available is 50 gpm. Find (a) the total heat lost by the air: (b) the final temperature of the air: (c) the final temperature of the water.

Solution: Since the air is the warmer fluid,

$$Gs = 9000 \times \frac{60}{13.3} \times 0.24 = 9750$$

$$G's' = 50 \times 8.33 \times 60 \times 1 = 25{,}000$$

(a)

$$M = \frac{UA}{Gs}\left(1 - \frac{Gs}{G's'}\right)$$

$$= \frac{12 \times 1575}{9750}\left(1 - \frac{9750}{25{,}000}\right) = 1.183.$$

Referring to Col. 4, Table 1, for $M = 1.183$, find in Col. 2,

$$\frac{D_m}{D_L} = F = 0.589$$

$$L = G's' = 25{,}000$$

$$H = \frac{L(t_1 - t_1')}{1 + \dfrac{L}{UAF}}$$

$$H = \frac{25{,}000(95 - 57)}{1 + \dfrac{25{,}000}{12 \times 1575 \times 0.589}} = \frac{25{,}000 \times 38}{3.245}$$

$= 293{,}000$ Btu per hr total heat lost by the air.

(b) $293{,}000 = 9750\ (95 - t_2)$

$$95 - t_2 = \frac{293{,}000}{9750} = 30 \text{ deg}$$

$t_2 = 65$ deg, final temperature of the air.

(c) $293{,}000 = 25{,}000\ (t_2' - 57)$

$$t_2' - 57 = \frac{293{,}000}{25{,}000} = 11.7 \text{ deg}$$

$t_2' = 68.7$ deg, final temperature of the water.

It is interesting to note, from the preceding example, that in counterflow it is possible to cool the air to a final temperature lower than the final temperature of the water. This would be impossible in parallel flow.

Example 12 (Classes 2 and 3): An air volume of 5000 cfm having an initial temperature of 45 deg flows through an air heater having an area of 765 sq ft. The air is heated by water having an initial temperature of 105 deg. The quantity of water circulated is 35 gpm. The value of U is 10. Find the final temperature of the air.

Solution: Since the water is the warm fluid,

$$Gs = 35 \times 8.33 \times 60 \times 1 = 17{,}500$$

$$G's' = 5000 \times \frac{60}{13.3} \times 0.24 = 5420$$

$$M = \frac{UA}{Gs}\left(1 - \frac{Gs}{G's'}\right)$$

$$= \frac{10 \times 765}{17{,}500}\left(1 - \frac{17{,}500}{5420}\right)$$

$$= 0.437\ (1 - 3.23)$$

$$= 0.437 \times -2.23 = -0.975$$

(In using Table 1, the negative sign in the preceding value of M can be disregarded entirely and the value of M treated as a positive number, as heretofore. The significance of the negative sign will be explained later.)

Table 1—Data for Solving Heat Transfer Problems

$\frac{Ds}{DL}$	$\frac{Dm}{DL}$	$\frac{Ds}{Dm}$	M	$\frac{Ds}{DL}$	$\frac{Dm}{DL}$	$\frac{Ds}{Dm}$	M
Col. 1	Col. 2	Col. 3	Col. 4	Col. 1	Col. 2	Col. 3	Col. 4
				0.50	0.721	0.693	0.693
0.01	0.215	0.046	4.605	.51	.728	.701	.674
.02	.251	.080	3.912	.52	.734	.708	.654
.03	.277	.109	3.507	.53	.740	.716	.635
.04	.298	.135	3.219	.54	.746	.724	.616
0.05	0.317	0.158	2.996	0.55	0.753	0.731	0.598
.06	.334	.180	2.814	.56	.759	.738	.580
.07	.350	.200	2.660	.57	.765	.745	.562
.08	.364	.219	2.526	.58	.771	.752	.545
.09	.378	.238	2.408	.59	.777	.759	.528
0.10	0.391	0.256	2.303	0.60	0.783	0.767	0.511
.11	.403	.273	2.207	.61	.789	.773	.494
.12	.415	.289	2.120	.62	.795	.780	.478
.13	.427	.305	2.040	.63	.801	.786	.462
.14	.438	.320	1.966	.64	.806	.794	.447
0.15	0.448	0.335	1.898	0.65	0.813	0.800	0.431
.16	.458	.349	1.833	.66	.818	.807	.415
.17	.469	.363	1.772	.67	.823	.814	.401
.18	.478	.377	1.716	.68	.829	.820	.386
.19	.488	.390	1.660	.69	.836	.826	.371
0.20	0.497	0.402	1.609	0.70	0.840	0.833	0.357
.21	.506	.415	1.561	.71	.848	.838	.342
.22	.515	.427	1.514	.72	.852	.845	.329
.23	.524	.439	1.470	.73	.858	.851	.315
.24	.533	.451	1.427	.74	.864	.856	.301
0.25	0.541	0.462	1.386	0.75	0.870	0.862	0.287
.26	.549	.473	1.347	.76	.874	.870	.275
.27	.558	.484	1.309	.77	.879	.876	.262
.28	.566	.495	1.273	.78	.886	.881	.248
.29	.574	.506	1.238	.79	.890	.887	.236
0.30	0.582	0.516	1.204	0.80	0.896	0.893	0.223
.31	.589	.526	1.171	.81	.902	.899	.211
.32	.597	.536	1.139	.82	.907	.904	.198
.33	.604	.546	1.109	.83	.913	.910	.186
.34	.612	.556	1.079	.84	.918	.915	.174
0.35	0.619	0.565	1.050	0.85	0.923	0.921	0.163
.36	.626	.575	1.022	.86	.928	.927	.151
.37	.634	.584	.994	.87	.934	.932	.139
.38	.641	.593	.968	.88	.939	.938	.128
.39	.648	.602	.942	.89	.944	.943	.117
0.40	0.655	0.611	0.916	0.90	0.949	0.948	0.105
.41	.662	.620	.892	.91	.955	.953	.094
.42	.669	.628	.868	.92	.959	.959	.083
.43	.675	.637	.844	.93	.964	.965	.073
.44	.682	.645	.821	.94	.970	.969	.062
0.45	0.689	0.653	0.798	0.95	0.975	0.974	0.051
.46	.695	.662	.777	.96	.979	.980	.041
.47	.702	.670	.755	.97	.986	.984	.030
.48	.709	.677	.734	.98	.991	.989	.020
.49	.715	.686	.713	.99	.995	.995	.010

D_L = large temperature difference, and D_s = small temperature difference used in determining log mean temperature difference, D_m. See text for the various formulas for M.

Referring to Col. 4, Table 1, for $M = 0.975$, find in Col. 2,

$$\frac{D_m}{D_L} = F = 0.641$$

$$L = Gs = 17{,}500$$

$$H = \frac{L(t_1 - t_1')}{1 + \dfrac{L}{UAF}}$$

$$= \frac{17{,}500(105 - 45)}{1 + \dfrac{17{,}500}{10 \times 765 \times 0.641}} = \frac{1{,}050{,}000}{4.565}$$

$= 230{,}000$ Btu per hr total heat lost by the water

$230{,}000 = 5420\ (t_2' - 45)$

$$t_2' - 45 = \frac{230{,}000}{5420} = 42.5 \text{ deg}$$

$t_2' = 87.5$ deg, final temperature of the air.

A negative sign before the numerical value of M, as

The computation of heat transfer problems may be divided into three main divisions: (1) Condensing or vaporizing. (2) Parallel flow. (3) Counterflow.

In heat transfer problems which arise in actual work, it is usually necessary to find the numerical answer of one of the following five quantities:

Class 1: A	**Area of surface required**
Class 2: H	**Total heat transferred from one fluid to the other**
Class 3: t_2 or t_2'	**Final temperature of either the warm or cool fluid**
Class 4: t_1 or t_1'	**Initial temperature of either the warm or cool fluid**
Class 5: G or G'	**Required weight of either the warm or cool fluid**

in the preceding example, indicates only that the large temperature difference occurs at the right-hand side of the heat transfer surface, as in Fig. 8, instead of the left-hand side, as in Fig. 6. When M is positive, the large temperature difference occurs at the end of the heat transfer surface where the warm fluid is entering; when negative, the large difference occurs at the end where the warm fluid is leaving.

Example 13 (Classes 3 and 5): Brine having an initial temperature of 32 deg is used to cool water in a double pipe cooler. The water enters at a temperature of 50 deg and is to be cooled to 38 deg. The quantity of water to be cooled is 150 gpm. The area of the heat transfer surface is 605 sq ft and the value of U is 190. Find the quantity of brine needed and its final temperature. Assume that the specific heat of the brine is 0.73 and its specific gravity is 1.18.

Solution: Since the water is the warmer fluid,

$$Gs = 150 \times 8.33 \times 60 = 75{,}000$$

Heat lost by the water is,

$$H = 75{,}000 \quad (50 - 38)$$
$$= 900{,}000 \text{ Btu per hr}$$
$$H = U \times A \times D_m$$
$$D_m = \frac{900{,}000}{190 \times 605} = 7.83 \text{ deg.}$$

Now at the end of the cooler where the water leaves and the brine enters, the temperature difference is 38 — 32 or 6 deg. But the question is whether the value of 6 deg is the large or small temperature difference; in other words, are the temperature curves similar to those in Fig. 6 or those in Fig. 8? In order to answer this question, it is necessary only to remember that the value of D_m must always lie somewhere between the values of D_L and D_s; in other words, the mean temperature difference must always be less than the large difference and greater than the small difference.

From the preceding computations, the mean temperature difference is 7.83 deg, while the known temperature difference is 6 deg. Therefore, 6 deg is the value of the small temperature difference, and the temperature curves will be similar to those of Fig. 6.

Therefore,

$$D_s = 6 \text{ and } D_m = 7.83$$
$$\frac{D_s}{D_m} = \frac{6}{7.83} = 0.766$$

Referring to Col. 3, Table 1, for $\frac{D_s}{D_m} = 0.766$, find in the first column,

$$\frac{D_s}{D_L} = 0.6 = \frac{6}{D_L}$$
$$D_L = \frac{6}{0.6} = 10 \text{ deg}$$

Referring to Fig. 6, the final temperature of the brine is,

$$t_2' = t_1 - D_L$$
$$= 50 - 10 = 40 \text{ deg}$$

The required weight of brine is found as follows:

$$900{,}000 = G' \times 0.73 \quad (40 - 32)$$
$$G' = \frac{900{,}000}{0.73 \times 8} = 154{,}000 \text{ lb per hr}$$

To convert to gpm,

$$\frac{154{,}000}{8.33 \times 1.18 \times 60} = 261 \text{ gpm}$$

Example 14 (Class 4): Air leaves a silica gel dehumidifier at a temperature of 130 deg and is to be cooled to a final temperature of 70 deg. The total volume of air to be cooled is 7500 cfm. The cooling coils have an area of 1800 sq ft and the coefficient U is 12. If the quantity of water available is 35 gpm, find the highest initial temperature at which the water may be delivered to the coils.

Solution: Since the air is the warm fluid,

$$Gs = 7500 \times \frac{60}{13.3} \times 0.24 = 8130$$

$$G's' = 35 \times 8.33 \times 60 = 17{,}500$$

$$M = \frac{UA}{Gs}\left(1 - \frac{Gs}{G's'}\right)$$

$$M = \frac{12 \times 1800}{8130}\left(1 - \frac{8130}{17{,}500}\right) = 1.42$$

Now if Fig. 6 represents the temperature curves, subtracting the small difference D_s from the final air temperature will give the required initial water temperature. On the other hand, if the temperature curves are as represented in Fig. 8, it will be necessary to subtract the large difference D_L from the final air temperature in order to find the initial water temperature. In this problem, as can be seen from the above computations, $\frac{Gs}{G's'}$ is less than one. Therefore, the temperature curves for this problem are similar to those in Fig. 6. In order to find the initial water temperature, it will first be necessary to find the small temperature difference D_s.

Referring to Col. 4, Table 1, for $M = 1.42$, find in Col. 3,

$$\frac{D_s}{D_m} = 0.451$$

$$H = 8130\ (130 - 70) = 488{,}000 \text{ Btu per hr}$$

$$D_m = \frac{H}{U \times A}$$

$$= \frac{488{,}000}{12 \times 1800} = 22.6$$

$$\frac{D_s}{22.6} = 0.451$$

$$D_s = 0.451 \times 22.6 = 10.2 \text{ deg}$$

Referring to Fig. 6,

$$t_1' = t_2 - D_s = 70 - 10.2$$
$$= 59.8 \text{ deg, required initial temperature of water.}$$

It should be mentioned that true counterflow of two fluids is rarely obtained in commercial apparatus. In air cooling coils, for instance, the air flows not along the tubes but in a direction perpendicular to them; in other words, cross-flow is obtained. However, in the usual installation, several rows of tubes are used, and the water travels back and forth through the tubes, crossing the air stream several times. Under these conditions, the true mean temperature difference is very close

to that obtained for true counterflow, the difference between the two values being negligible. In any actual coil, the water should, of course, first enter the last row of tubes with which the air is in contact, and should leave the coil through the first row of tubes with which the air is in contact. [*Concluded*]

APPENDIX

Derivation of Formula 6

Refer to Fig. 6, for which the value of $\frac{Gs}{G's'}$ is less than one.

From Formula 1,

$$D_m = \frac{H}{U \times A} \quad \text{.....[a]}$$

Divide both sides by D_L:

$$\frac{D_m}{D_L} = \frac{H}{U \times A \times D_L} \quad \text{.....[b]}$$

Let

$$\frac{D_m}{D_L} = F \quad \text{.....[c]}$$

$$F = \frac{H}{U \times A \times D_L} \quad \text{.....[d]}$$

$$D_L = \frac{H}{U \times A \times F} \quad \text{.....[e]}$$

Referring to Fig. 6,

$$D_L = t_1 - t_2' \quad \text{.....[f]}$$

$$t_1 - t_2' = \frac{H}{U \times A \times F} \quad \text{.....[g]}$$

Now,

$$H = G's' (t_2' - t_1') \quad \text{.....[h]}$$

$$t_2' - t_1' = \frac{H}{G's'} \quad \text{.....[j]}$$

Eliminate t_2' between Formulas g and j and solving for H obtain,

$$H = \frac{G's' (t_1 - t_1')}{1 + \frac{G's'}{UAF}} \quad \text{.....[k]}$$

In the same way, by referring to Fig. 8, for which $\frac{Gs}{G's'}$ is greater than one, it is possible to obtain,

$$H = \frac{Gs (t_1 - t_1')}{1 + \frac{Gs}{UAF}} \quad \text{.....[l]}$$

Notice that [k] and [l] above are identical except for the factors Gs and $G's'$. However, notice also that for the conditions of [k], $G's'$ must always be larger than Gs, if $\frac{Gs}{G's'}$ is to be less than one. For the conditions of [l], Gs must always be larger than $G's'$ if $\frac{Gs}{G's'}$ is to be greater than one. Therefore, by always using either Gs or $G's'$, depending upon which is larger, it is possible to combine [k] and [l] in one formula:

$$H = \frac{L(t_1 - t_1')}{1 + \frac{L}{UAF}}$$

This is Formula 6 of the text. In any actual problem, L is equal either to Gs or $G's'$ depending upon which one is larger.

Table 1

Column 2 was computed from the formula:

$$\frac{D_m}{D_L} = \frac{1 - \frac{D_s}{D_L}}{\text{Log}_e \frac{D_L}{D_s}}$$

Column 3 was computed from the formula:

$$\frac{D_s}{D_m} = \frac{\text{Log}_e \frac{D_L}{D_s}}{\frac{D_L}{D_s} - 1}$$

Column 4 was computed from the formula:

$$\text{Log}_e \frac{D_L}{D_s} = M$$

[*Concluded from page* 154]

lapped edges which effects the welding.

The hammer weld method is used mainly for very large diameters. This type of weld is probably of greater uniformity of strength than any of the others. The process is more costly than other types, and so its use is limited to special work.

Electrical welding embraces many different procedures. All of them involve heating to the welding temperature, at least, and some to the temperature of the melted metal. The pipe is formed from plates or strips, as in the other welded process, and the edges joined by a weld.

The first step in making seamless pipe is to put a hole through a heated round bar long enough to provide the material needed in the finished tube. This is done by a pair of rolls rotating on axes inclined slightly to the axis of the bar. Rotation of the rolls causes the bar to rotate and to travel lengthwise. A conical shaped mandrel is supported at a suitable position between the rolls and in the line of the axis of the bar. As the bar advances by the motion of the rolls, it reaches the mandrel and flows over and around it. Thus the solid bar is made into a pipe. The relation of the length and diameter of the bar to those of the pipe may be varied over a wide range to suit the size of pipe being made. The walls of the pipe, as it leaves the piercing mill, as the pair of rolls is called, are much thicker than is needed for pipe generally. The required thickness of the final product is secured by subsequent operations.

The operations involved in converting a round solid bar to a seamless pipe, one following another in a continuous process, are:

1. Pierce the solid round bar to tubular.
2. Roll the wall of the pierced pipe to the finished wall.
3. Smooth and finish the inside and outside surfaces.
4. Reduce to the finished diameter.

The sequence of operations limited the diameter of the pipe to approximately 14 in. In 1928 the rotary rolling operation was introduced between the second and third steps in the sequence for pipe of over 14 in. in diameter. By this means the diameter range was greatly extended, the mill being capable of producing diameters up to 24 in.

Heating System Control Methods and Reducing Fuel Consumption

By Kalman Steiner*

Typical methods of control that operate exclusively upon the heating system are described briefly, followed by a discussion of radiator orificing, the correction of piping defects to enable economical operation of heating systems, and suggestions for analyzing comparative fuel consumption data . . . . . Economies that can be effected in the operation and maintenance of the heating plant itself, and savings that can be achieved by changes in the heating system and in the building construction, are briefly outlined

ALL four of the systems of heating control described in my article last month[1] can be used either for the direct operation of the stoker, oil burner, or gas burner, or for controlling a master steam valve. In the latter event the steam valve may regulate steam admission to an entire building, or to one zone of a building. When zoning is employed, each zone responds individually to its own control instrument.

Typical Methods of Controlling Heating Systems

There are also steam control systems that operate exclusively upon the heating system, leaving the burner or firing device entirely under control of a pressurestat on the boiler; typical systems of this nature are as follows:

Example No. 1—Steam admission and steam distribution are the two fundamentals of the differential vacuum heating system. Control of steam admission is accomplished by a balanced steam valve in the steam main, which may be situated either at the boiler or at the entrance to a zone. This valve responds to impulses from various sources—a heat balancer, room thermostats and a panel board. Steam distribution is secured by (1) a vacuum pump which can develop vacuums throughout the system up to 25 in., and (2) by orificing of the radiators. The heat balancer consists of a thermometer bulb inserted into a control radiator, and so connected as to send electric signals to the balancer panel, in response to temperature changes within the radiator. The vacuum developed by the pump is regulated from a differential controller, which is actuated by the difference in pressure between the steam supply main and the return main. The thermostats are placed throughout the building at strategic locations, and the readings of all these thermostats are averaged so that as each thermostat calls for heat, it causes the opening of a balanced steam valve by a uniform increment.

Example No. 2—Steam admission and steam distribution are controlled in this system by means of four elements: an outside roof thermostat, a manually manipulated compensator, a central control panel, which also contains a mercury device for maintaining uniform differential between steam and return lines, and a balanced steam valve placed at the entrance to the building heating system or to a zone of a heating system. The system may be operated either electrically or pneumatically.

In the electrical type, the roof thermostat consists of a bimetal coil enclosed within a weatherproof housing on the roof of the building, together with a series of electrical contacts. Changes in outside temperature cause the bimetal coil to transmit motion to a sliding contact which in turn sends electrical impulses down through corresponding contacts which communicate into the control cabinet in series with the compensator. When the compensator is in normal position, the roof thermostat will cause the steam valve to assume a position proportional to the severity of the weather. The compensator may be manually set, however, to compensate for unusual conditions, such as quick morning heating up, night time and holiday reduced temperature or high winds. Signals from both roof thermostat and compensator may again be modified while passing through the control cabinet, to compensate for any variation in the pressure differential between steam and return piping which would change the rate of steam flow from the normal. All radiators are orificed for a fixed pressure differential.

In the pneumatic type, the operation is essentially the same, except that compressed air is the medium used to actuate the system instead of electricity. The roof thermostat is built up of a steel tube about 6 ft long, inside of which is a brass tube fastened at the top to the steel tube. The lower end of the brass tube is free to move, and the motion which occurs when temperature changes affect it is transmitted to an air valve which in turn controls operation of the rest of the system as above described for electrical operation. The compensator device in either case need not be located in the boiler room but can be placed at the most convenient point for the attendant in charge of the heating plant.

As above described, this control method is based upon continuous steam flow, modulated by the position of the steam valve. The system is also made in a form which will give pulsating action by periodic timing of the opening and closing of the steam valve, in short and frequent intervals. The pneumatic type is also available in a simplified form for manual setting of a counter-weight on the diaphragm mechanism, the position of the weight being selected according to the severity of the weather.

*Ace Engineering Co., Chicago, Ill. Copyright, 1937, by Kalman Steiner.

[1] "Heating System Control Methods for Reducing Fuel Consumption," by Kalman Steiner, HEATING, PIPING AND AIR CONDITIONING, February, 1937, pp. 85-88.

This diaphragm mechanism can then be utilized either for control of the steam valve, or for direct connection to the electrical circuit of the oil burner or stoker.

Example No. 3—This is an automatically controlled steam circulating system. The control is accomplished by means of a floating type of valve situated in the steam main at the source of supply, or in the branch mains at the entrances to each zoned circuit. This valve is responsive to the varying requirements of one or more infiltration thermostats and controls the flow of steam through a full range of heating pressures from about 3 lb down to as low as 24 in. of vacuum. The thermostat is mounted on the inside face of an outside wall near the return end of a radiator which is normally situated at or near the end of the steam circuit. The thermostat, due to its location and design, responds quickly to changes in heating requirements, whether these are due to changes in outside temperature, wind, or sun effect. To maintain comfort conditions within the building or zone, this thermostat determines the position of the floating type valve to admit the required amount of steam to just balance the heat losses. A vacuum pump is used for rapid and complete circulation of steam, and this pump is equipped with a selective controller to insure automatic operation of the pump at the highest vacuum commensurate with the temperature of the returns, and is operative throughout the entire pressure-vacuum range of the system. This system may be operated either electrically or pneumatically, and manual control may be provided where required.

Radiator Orificing

The orificing of radiators serves two functions. First, uniform distribution throughout the entire building or zone is achieved. The rush of steam into near radiators is avoided and thus the far radiators can receive steam at about the same time. Second, orifices are so designed that the radiator is completely filled with steam only at the one pressure differential (between supply and return mains) upon which the orifice size has been based. When the pressure differential is held at some point less than this maximum value, the orifice will permit only enough steam to flow into the radiator as to partially fill it. In this way the heat output of a heating system can be varied by changing the pressure differential across the orifices, even though the flow of steam is continuous. In selecting the orifice diameter, it is necessary to consider the size of the radiator, the operating differential, and the distance of any particular radiator from the steam source.

Orificing has also been adapted, in recent years, to one pipe gravity systems. In this case the operation or flow is intermittent. During the period that steam is flowing, condensate collects in the radiator. While steam is shut off, condensate runs back through the orifice and returns to the boiler. For successful results, the on and off periods should be short and of frequent occurrence.

Correcting Piping Defects in Heating Systems

Intelligent and effective use of a modern temperature control system is largely dependent upon rapid and uniform steam circulation throughout the system. Any defects in a heating system which tend to retard or obstruct the flow of steam will promptly cause heating difficulties and give rise to complaints from building occupants. Oddly enough, one of the most flagrant and common causes of poor circulation is the one easiest to correct—improper slope or pitch in the radiator runout pipes which connect the radiator to the steam and return risers. Sometimes this is due to poor steamfitting, but more commonly it arises sometime after the installation of the heating plant has been completed because of settling of the building, changes in radiator location, etc. Other piping defects encountered are trapped conditions in mains created by improper pitch, by pockets due to pipe dips, by poor or defective dripping of risers and the ends of mains, and by sluggish removal of air from

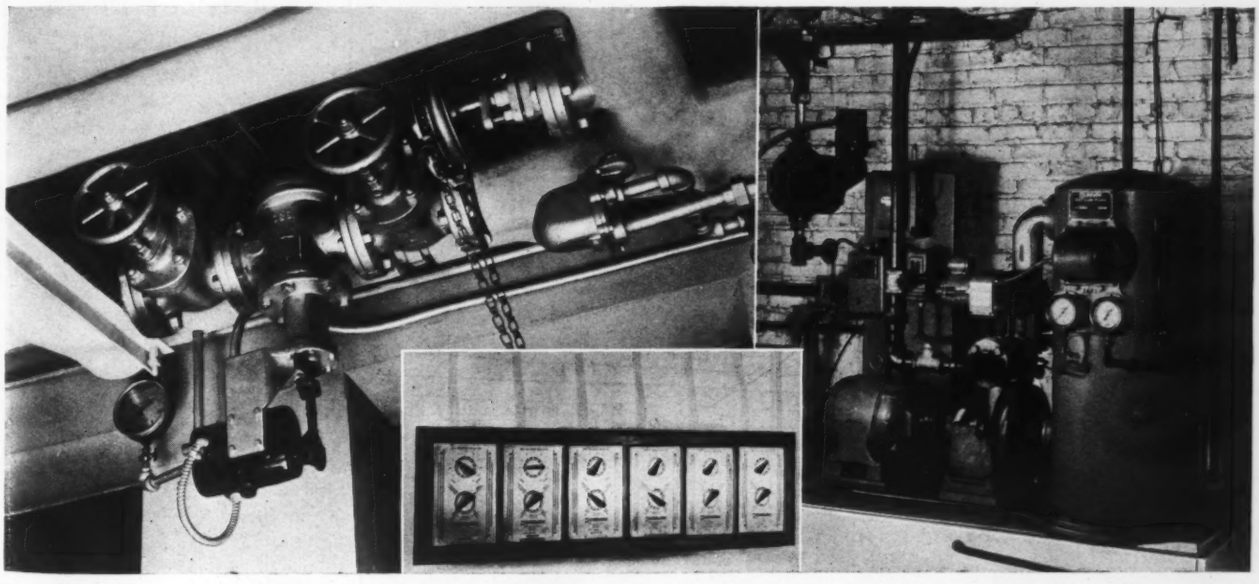


Photo courtesy C. A. Dunham Co.

Control valve, differential pump, and panel board for control of a six zone heating system

Economies To Be Effected Through Operation and Maintenance of the Heating Plant

Steam should reach all radiators at approximately the same time. If steam must be supplied for unnecessarily long periods of time in order to heat a few sluggish radiators, fuel will be wasted. Sluggish heating of radiators is due to either trapped supply or return branches, or to air binding.

It is important that leaking traps and valves be replaced.

Water storage tanks are often installed on the roofs of buildings to provide water for fire protection systems. Steam heaters are usually provided to prevent freezing in cold weather. There is no need for heating these tanks in mild weather. Steam should be turned into these tanks only in freezing weather.

Supply heat only when needed. Do not supply heat nights, week-ends, or holidays. Supply only enough heat to obviate difficulties in building equipment.

Shut off radiators in unoccupied portions of the building. During freezing weather, turn on only enough radiators to keep the room temperature above freezing.

Keep the temperature of building as low as is consistent for comfort. Though temperatures of 80 deg may be required in a hospital, temperatures higher than 72 deg are seldom justifiable in offices or homes. Where a few tenants insist on "hot house" temperatures, it is better to install oversized radiators for them than to over-heat the entire building.

Temperatures of 50 to 60 deg are satisfactory for space in which men are engaged in active work—not in sedentary bench work. This applies to many shops and garages.

Most ventilating systems can deliver far more air than is actually needed. Reduce your air supply to the quantity actually needed. A large amount of fuel is needed during cold weather to heat outdoor air up to building temperatures. Large savings in fuel can be made by reducing the air supply, without sacrificing the comfort of the building occupants insofar as it is affected by the ventilating systems.

the system. In practically every application of control to a heating system some defective conditions will be found to exist. Satisfaction can be obtained only by locating and eliminating these defects.

Fuel Consumption Estimates and Comparisons

Although heating is a branch of engineering, it is very difficult indeed to subject the economics of heating to the same mechanical analysis which is possible in many other branches of engineering—at least not within any acceptable degree of accuracy. For one thing, reliable data on heating costs are not abundant. For another, such data as are available cannot be rigidly analyzed because of the manifold complications which enter into a tabulation of the factors influencing heating costs and fuel consumption. Finally, fuel in unknown quantities is consumed in most buildings for other purposes, especially hot water heating. Usually an exact division cannot be made between the various uses for which fuel is expended.

Such attempts as have been made to set up a scale of comparison for fuel consumption for building heating are based upon fuel used per unit of radiation, or unit of building volume, or unit building heat loss per degree day, or per 1000 degree days. The degree day is usually conceived of as a temperature deficiency of 1 deg through which a building must be heated for 24 hr when the outside temperature is below 65 F. To allow for reduced night temperature, it is customary to compute degree days by deducting from 65 the average outside temperature for some period of time, usually a month, and to multiply the difference by the number of days in this period of time. Thus, if in some particular locality the mean outside temperature for the month of January were 23.7 F, then the degree days for that month and locality would be $(65.0 - 23.7) \times 31 = 1280.3$. Variations of this are employed, using other base temperatures, as for industrial buildings where the maintained daytime temperature is less than 70 F. The degree day is widely used in the heating profession, and offers the

Economies Which Can Be Effected by Changes in Heating Systems and Building Construction

All steam piping should be covered. Nothing is gained by heating attics or basements.

A sheet of insulating material behind radiators under windows prevents the loss of heat to the outside through the wall behind the radiator. This is particularly necessary when the radiator is recessed. The wall behind radiator recesses is usually thin.

Ordinary radiators should not be covered with the totally enclosed, ornate cabinets so often seen, even when the radiator has been over-sized in order to offset the heating capacity of the radiator through the cover. The circulation of the air is affected to such an extent by the cover that steam must be supplied for excessively long periods to heat rooms having radiators covered in this manner.

Temperature control of the building is always desirable.

Hot water for the faucet supply, when heated by steam, should be thermostatically controlled. For ordinary building service, water should never be supplied above 140 deg. Very often cooler water than this will be satisfactory.

All control equipment and valves needed for the daily operation of the plant should be conveniently situated.

Orifices installed in the supply valves to all radiators are beneficial in that all of the radiators will heat uniformly. The last radiator will receive heat as soon as the first one. This eliminates overheating of most of the building in order to heat rooms whose radiators are last on the steam main.

Install over-sized radiators for the few tenants who insist on the maintenance of "tropical" 80 deg temperatures. It is cheaper to do this than it is to carry the whole building at this temperature for a few tenants. The policy of over-heating a building for some few tenants will result in open windows all over the buildings with a resultant waste of heat.

Radiators heat rooms more satisfactorily if they are placed on outside walls. Best of all is the location of a radiator under the window.

Separate steam lines should be installed for the portions of a building that must be heated all night. This is cheaper than heating a whole building in order to provide heat for just a small part of it during the night.

Shipping and receiving rooms should be separate from other rooms. The doors to shipping and receiving rooms should have automatic door closers.

Entrances to the building should have vestibules with two sets of doors, or revolving doors.

All windows should be weatherstripped and all window frames caulked.

Insulate walls and roof if possible.

most satisfactory basis for expressing heating plant load conditions so far developed; but it is yet doubtful whether the method has been established as a standard conforming to the accuracy of other engineering or scientific standards.

For any one building, it is probable that satisfactory comparisons of fuel consumption can be made for different periods of time, such as different heating seasons or different months, by employing the degree day method. Even then it will generally be found that unit fuel (or steam) consumption per degree day will vary with the time of year, severity of weather, variations of climatic conditions, etc., assuming that all other factors, such as building tenancy and hours of heating, are held constant. However, when this method is used to compare the fuel or steam consumption of different buildings, especially in widely separated localities, there is opportunity for large discrepancies to enter into fuel comparisons. A more (or less) conservative heat loss may have been allowed for in the designs, the building engineers may have divergent opinions and methods of firing and operating the heating plant apparatus, the percentage and character of building tenancy and the hours of heating may vary, the climatic conditions will be dissimilar, and numerous other factors will be at variance with each other—when the fuel consumption for heating one building is compared with that of a supposedly comparable building in another locality.

What to Consider in Analyzing Fuel Consumption

When an analysis is attempted of comparative fuel consumption data, the following factors at least should be considered with respect to their influence upon the heating of the building, and the effectiveness of fuel utilization:

Load in square feet of radiation or Btu loss from building.
Degree days for the period and locality under consideration.
Base temperature used in design of the heating system.
Daily hours of heating, and number of days per week.
Maintained inside temperature.
Percentage of building occupancy, and character of tenancy and uses for which building is employed.
Amount of ventilation or frequency of air changes.
Combustion efficiency of the boiler plant.
Nature and condition of the heating plant control.

Economy in operation of the heating plant can be achieved by changes which are divided broadly into two classes:

1. Those which can be achieved by changes in operating methods and maintenance of the heating plant.
2. Those which can be achieved in either the heating plant or the building construction.

Changes in the first class are usually easy to make. They call only for some thought and alertness on the part of the building operator. Although there are many changes in the second class which it would be impractical to make because of the investment required, there are nevertheless many which are more than justified by the savings incurred. Unless there are prohibitive difficulties because of building construction, possible changes which fall in the second class should be carefully analyzed before being definitely rejected.

Hotel Air Conditioning—

[*Concluded from page* 164]

to the individual guest and sample rooms. The sizes of the distribution ducts are reduced after each take-off to the rooms and velocity is reduced proportionately to 600 fpm at the end of these ducts. The air velocity in the branches to the individual rooms is 400 fpm at which velocity the air is delivered through the grilles to the rooms. The supply duct for the sixth floor branches from the main riser in the attic space of the old building and the supply ducts for the seventh and eighth floors branch from the riser before it enters the roof of the old building. Each of these three supply ducts is divided into two main distribution ducts, one on each side of the halls of the respective floors with supply branches to the individual rooms.

Harrington Hotel

Manually operated dampers have been provided at the outlets of the individual supply ducts to permit the occupants of rooms to regulate the amount of conditioned air supplied to them. Due to the great variation in sensitivity of people to conditioned air, particularly during the summer season, some guests often desire less cooling than is recommended by the air conditioning industry, and for this reason the manual control has been provided. This manual control is also available to the management to permit shutting off rooms which are unoccupied, thus reducing the operating cost of the system.

A control actuated by a variation of the static pressure in the system has been provided to operate the variable vortex on the inlet of the fan. This is necessary to reduce the total amount of air supplied and insures a constant air delivery to the remaining rooms when individual rooms are removed from the system by the occupants, or when the management shuts off parts of the hotel which are unoccupied.

The return air from all rooms enters the halls through transoms permanently blocked open. The air from the first to fifth floors of the old and new buildings is returned via the halls of each floor to the front stairwell and thence to the air conditioner situated on the penthouse directly above the stairwell. The air returned from the sixth to eighth floors inclusive is conducted by separate ducts from the ends of the halls of the individual floors to the air conditioner. Return air is taken from all of the floors except the mezzanine. The air supplied to this floor is allowed to spill into the lobby and lounge to afford a certain amount of cooling in these areas. Thus the hotel has the unusual condition during the cooling season whereby guests are introduced to the rooms in graduated changes, first to the lobby which is partially cooled, then to the halls which are slightly lower in temperature, and finally the rooms where comfort conditions are maintained.

The Strength and Design of Covers and Flanges for Pressure Vessels and Piping

[Part 5]

By T. McLean Jasper*, H. Gregersen*, and A. M. Zoellner*

THE construction of a vessel or pipe line for high pressure service involves a balance in the design at every point so that the safety of such equipment can be assured. Previous investigations have established the necessity for and the required amount of reinforcement for openings in vessel walls and for the proper shapes of heads of vessels. The present investigation aims to go into the question of covers and flanges of openings. Part 1, published in November, was concerned with covers and ring flanges; Parts 2 and 3, December and January, with hubbed flanges; and Part 4, February, with bolt loads and Appendix I on the test arrangement.

APPENDIX 2
TEST RESULTS

The material for the castings was prepared by pouring plaster of paris slowly into lukewarm water while the whole was stirred continuously. As the saturation point was reached the mass was poured quickly into the molds which were jarred sufficiently to cause the escape of gas bubbles. To retard setting, a small percentage of acetic acid was added to the water, facilitating the casting and assuring a more homogeneous material.

For each casting of a flange, two test bars of the approximate dimensions 20 × 1¼ × 1⅛ in. were cast. As the test proceeded these test bars were used for determination of the strength of each casting, and the properties of the material. The bars were tested in bending, in tension, and in compression. As a result of 136 bending tests and 63 tensile tests, made with specimens of the same castings, the modulus of rupture of the bending specimens was found to have the average value S_r (aver.) = 386 lb per sq in., and the tensile strength of the tensile specimens to have the average value S (aver.) = 318 lb per sq in. Thus the average ratio between the modulus of rupture and the tensile strength is approximately 1.2. The average compressive strength was found to be approximately four times the tensile strength.

It should be mentioned that the strength of the castings varied considerably with the quality of the commercial plaster of paris.

An investigation was made to determine if the strength of the material changes with age, but no change in strength could be observed after the castings had been seasoned. No castings were tested before they were about three weeks old in order to assure seasoned and homogeneous material.

The results of the deflection tests are shown in Fig. 22. As can be seen the load deflection curves are straight lines, proving that the material when stressed follows Hooke's law up to its ultimate strength. The average modulus of elasticity was calculated to be about 800,000 lb per sq in.

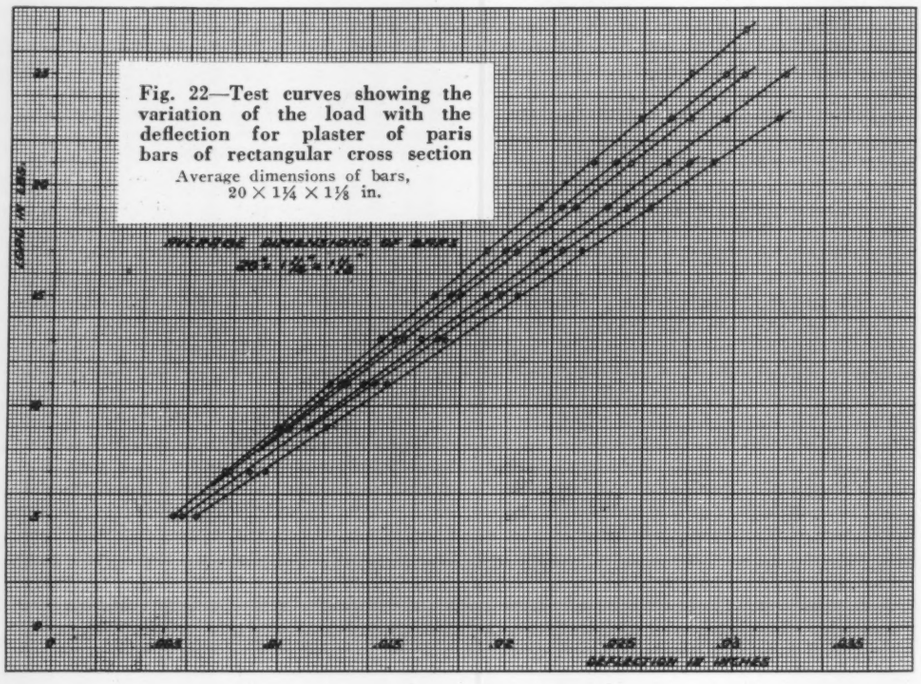


Fig. 22—Test curves showing the variation of the load with the deflection for plaster of paris bars of rectangular cross section
Average dimensions of bars, 20 × 1¼ × 1⅛ in.

Deflection Test of Plaster of Paris Bars
(Fig. 22 has been plotted from the values given in this table)

Load in Lb	Deflection in Inches					
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
5	0.0054	0.0054	0.0055	0.0058	0.0059	0.0064
7	0.0077	0.0079	0.008	0.0088	0.0088	0.0095
9	0.0100	0.0103	0.0105	0.0112	0.0113	0.0121
11	0.0123	0.0127	0.0131	0.0138	0.0142	0.0148
13	0.0145	0.0151	0.0155	0.0163	0.0170	0.0173
15	0.0169	0.0176	0.018	0.0191	0.0197	0.0205
17	0.0191	0.0199	0.0205	0.0216	0.0224	0.0233
19	0.0215	0.0224	0.0230	0.0244	0.0253	0.0263
21	0.0238	0.0248	0.0255	0.0271	0.0280	0.0291
23	0.0259	0.0272	0.0281	0.0297	.....	0.0320
25	0.0281	0.0297	0.0305	0.0323	.....	.....
27	0.0305	.....	.....	.....	.....	.....

It should also be mentioned that Poisson's ratio for the material was not determined. The reason for this is partly the difficulty involved in experimental determination of Poisson's ratio of brittle materials, and partly the minor influence of Poisson's ratio on the material strength.

*Research Engineer, A. O. Smith Corp., Milwaukee, Wis.
Illustrations reproduced by courtesy of the A. O. Smith Corp.
This paper was presented at the annual meeting of the *American Society of Mechanical Engineers*, December, 1934, New York, N. Y., but has not heretofore been available in published form.

Since the average tensile strength of 63 tensile specimens was 318 lb per sq in., this value has been assumed to be the basic tensile strength on which all theoretical curves are based, and to which all test results have been adjusted in proportion to the strength of the various castings. The results of the theoretical and experimental investigations are tabulated in the tables shown here, from which the graphs given in the report have been plotted. Together with each table, the dimensions of the test flanges are given and the flange dimensions used in the particular test are given in the first column of each table. The load W_{test} required in fracturing the flanges was measured

[*Continued on next page*]

Ring Flanges—Variation of Flange Thickness

(Fig. 4 has been plotted from the values given in this table)

Flange Dimensions
$D = 10.1$ In. $b = 9.4$ In. Ave. Tensile Strength
$d = 5.05$ In. $g = 5.57$ In. of Material:
$a = 1.915$ In. $S = 318$ Lb per Sq In.

$$S_{Test} = \frac{S_r \text{ Ave.}}{1.2}$$

$$M = \frac{318}{S_{Test}} M_{Test}$$

T	M_{Test}	S_r Aver.	S_{Test}	M
0.6	326	430	358	290
0.6	268	433	361	236
0.933	575	371	309	591
0.933	565	347	289	622
1.2	823	477	397	659
1.266	900	372	310	923
1.266	900	312	260	1100
1.266	1090	491	410	846
1.6	1570	419	349	1430
1.6	1665	392	326	1625
0.933	397	311	259	487
0.933	511	306	255	637
1.6	1190	282	235	1610
1.6	1515	303	252	1912

Ring Flanges—Variation of Flange Thickness

(Fig. 5 has been plotted from the values given in this table)

Flange Dimensions
$D = 16.35$ In. $b = 15.625$ In. Ave. Tensile Strength
$d = 10.9$ In. $g = 11.7$ In. of Material:
$a = 1.9625$ In. $S = 318$ Lb per Sq In.

$$S_{Test} = \frac{S_r \text{ Ave.}}{1.2}$$

$$M = \frac{318}{S_{Test}} M_{Test}$$

T	M_{Test}	S_r Aver.	S_{Test}	M
0.8	552	302	252	698
0.8	473	340	283	531
1.2	1120	325	271	1315
1.2	513	178	148	1102
1.6	2005	380	316	2020
1.6	1785	346	288	1970
2.0	2122	252	210	3220
2.0	2420	311	259	2980
2.0	1413	183	153	2940
2.0	1710	212	177	3070

Ring Flanges—Variation of Outside Flange Diameter

(Fig. 6 has been plotted from the values given in this table)

Outside Flange Diameter—Diameter of "Bolt Circle" $= D\text{-}b =$ Constant

Flange Dimensions
$d = 5.05$ In. $g = 5.57$ In. Ave. Tensile Strength
$T = 1.4$ In. $\frac{D\text{-}b}{2} = 0.35$ In. of Material:
$S = 318$ Lb per Sq In.

$$S_{Test} = \frac{S_r \text{ Ave.}}{1.2}$$

$$M = \frac{318}{S_{Test}} M_{Test}$$

D	$\frac{D\text{-}d}{2}$	b	a	M_{Test}	S_r Aver.	S_{Test}	M
8.25	1.6	7.55	0.99	498	178	148	1070
8.25	1.6	7.55	0.99	595	235	212	893
9.1	2.025	8.40	1.415	665	390	325	650
9.1	2.025	8.40	1.415	495	212	177	890
9.1	2.025	8.40	1.415	555	283	236	748
9.1	2.025	8.40	1.415	697	265	221	1000
11.75	3.35	11.05	2.74	1122	232	193	1850
11.75	3.35	11.05	2.74	823	178	148	1770
11.75	3.35	11.05	2.74	1221	429	357	1090
11.75	3.35	11.05	2.74	1320	365	304	1380

Hubbed Flanges—Variation of Flange Thickness and Fillet Radius

(Fig. 9 has been plotted from the values given in this table)

Flange Dimensions
$D = 10.1$ In. $b = 9.4$ In. Ave. Tensile Strength
$d = 5.05$ In. $g = 5.75$ In. of Material:
$t = 0.65$ In. $a = 1.915$ In. $S = 318$ Lb per Sq In.

$$S_{Test} = \frac{S_r \text{ Ave.}}{1.2}$$

$$M = \frac{318}{S_{Test}} M_{Test}$$

R	T	M_{Test}	S_r Aver.	S_{Test}	M
$R = 0$	0.6	345	306	255	430
$R = 0$	0.6	345	314	262	419
$R = 0$	0.933	517	274	228	720
$R = 0$	0.933	460	278	232	630
$R = 0$	1.266	690	251	209	1050
$R = 0$	1.266	900	295	246	1165
$R = 0$	1.6	1320	377	314	1335
$R = 0$	1.6	1070	376	313	1088
$R = \frac{1}{4}$	0.6	505	306	255	630
$R = \frac{1}{4}$	0.6	422	321	268	501
$R = \frac{1}{4}$	0.933	1013	459	382	844
$R = \frac{1}{4}$	0.933	871	346	288	961
$R = \frac{1}{4}$	0.933	741	311	259	910
$R = \frac{1}{4}$	0.933	511	244	203	800
$R = \frac{1}{4}$	1.266	1425	392	327	1388
$R = \frac{1}{4}$	1.266	1349	374	312	1373
$R = \frac{1}{4}$	1.266	857	306	255	1030
$R = \frac{1}{4}$	1.266	857	287	239	1142
$R = \frac{1}{4}$	1.6	1846	345	288	2040
$R = \frac{1}{4}$	1.6	1740	372	310	1785
$R = \frac{1}{2}$	0.6	518	374	312	528
$R = \frac{1}{2}$	0.6	765	420	350	695
$R = \frac{1}{2}$	0.8	1043	468	390	852
$R = \frac{1}{2}$	0.8	824	413	344	761
$R = \frac{1}{2}$	1.0	1110	413	344	1025
$R = \frac{1}{2}$	1.0	1130	436	364	988
$R = \frac{1}{2}$	1.2	1188	375	312	1210
$R = \frac{1}{2}$	1.2	1065	266	222	1525
$R = \frac{1}{2}$	1.4	1570	373	311	1605
$R = \frac{1}{2}$	1.4	1610	383	319	1605
$R = \frac{1}{2}$	1.6	1665	345	288	1840
$R = \frac{1}{2}$	1.6	2435	447	372	2080
$R = \frac{1}{2}$	1.6	1772	321	268	2100
$R = \frac{1}{2}$	1.6	1410	247	206	2175
$R = \frac{3}{4}$	0.6	939	400	334	894
$R = \frac{3}{4}$	0.6	920	424	353	828
$R = \frac{3}{4}$	0.933	1511	405	338	1420
$R = \frac{3}{4}$	0.933	1265	341	284	1415
$R = \frac{3}{4}$	0.933	760	264	220	1098
$R = \frac{3}{4}$	1.266	1837	392	326	1790
$R = \frac{3}{4}$	1.266	1760	357	298	1880
$R = \frac{3}{4}$	1.6	2720	444	370	2340
$R = \frac{3}{4}$	1.6	2790	417	348	2550
$R = \frac{1}{2}$ With Bolt Holes	0.933	995	464	386	820
$R = \frac{1}{2}$ With Bolt Holes	0.933	1025	385	322	1014
$R = \frac{1}{2}$ With Bolt Holes	1.6	2145	474	394	1730
$R = \frac{1}{4}$ With Bolt Holes	1.6	1645	443	369	1420

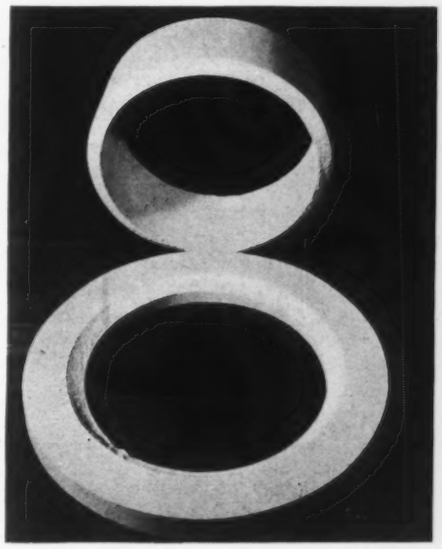
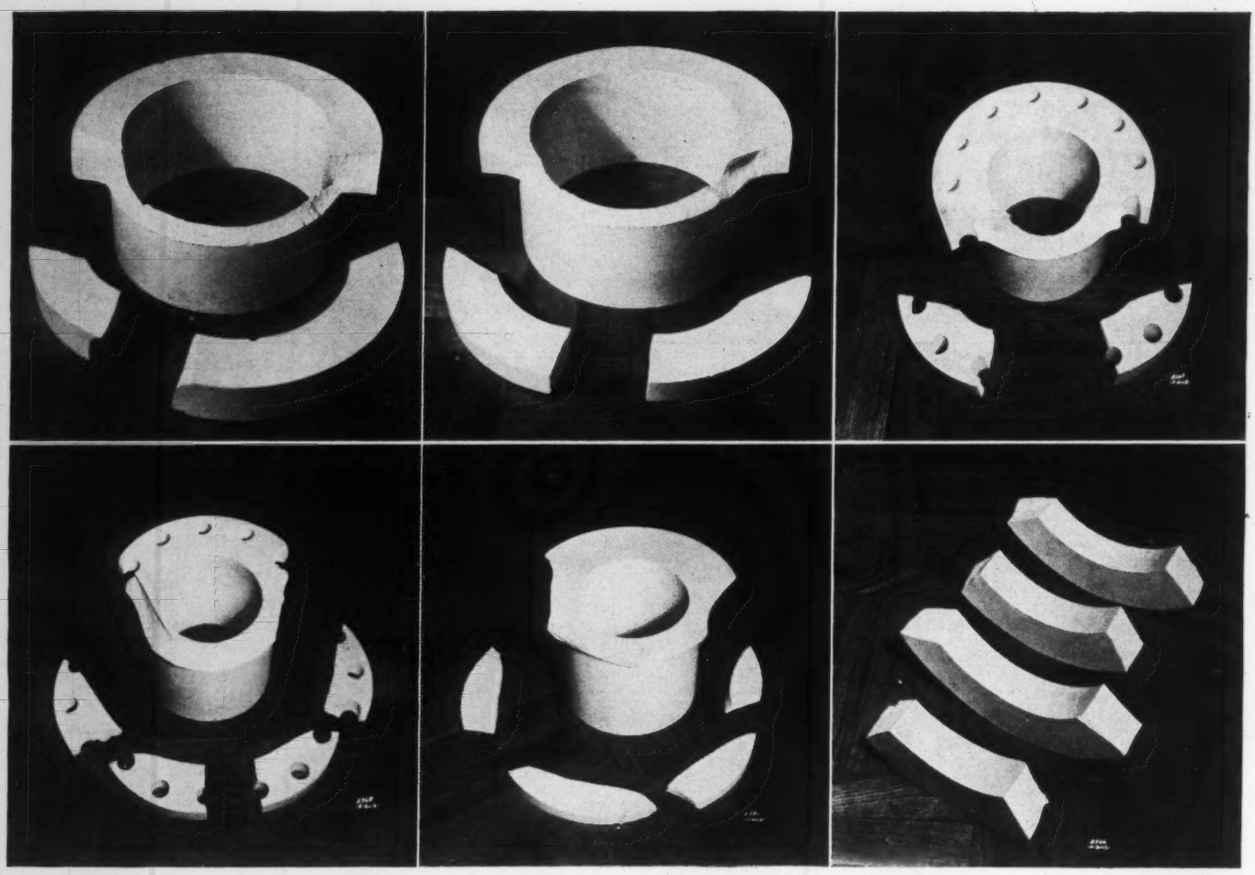


Fig. 23—Typical fracture of flange without fillet



Top row, left to right: **Fig. 24—Typical fracture of large flange with fillet and large flange thickness. . . . Fig. 25—Typical fracture of large flange with fillet and small flange thickness. . . . Fig. 26—Typical fracture of flange with bolt holes, fillet and large flange thickness**

Bottom row, left to right: **Fig. 27—Typical fracture of flange with bolt holes, fillet and small flange thickness. . . . Fig. 28—Typical fracture of small flange with fillet and small flange thickness. . . . Fig. 29—Typical fracture of ring flange**

and this value multiplied by a gave the external moment M_{test} which is given in the tables. The average modulus of rupture S_r (aver.) of each casting is given in the tables. Since the average ratio between the modulus of rupture and the tensile strength was found to be approximately 1.2 the tensile strength, S_{test} of

[*Concluded on page* 178]

List of Symbols Used

W—Total bolt load
G—Gasket load
D—Outside diameter of cover, ring, or flange
T—Thickness of hub in a hubbed flange
S—Stress
S_r—Modulus of rupture
$M = Wa$—External moment applied or assumed in design
M_o—Moment per unit length of circumference
Q—Force
Q_o—Shearing force per unit length of circumference
M_{test}—Moment applied in test samples at failure
S_{test}—Stress obtained in test samples at failure
b—Bolt circle diameter
g—Gasket diameter
d—Inside diameter of flange or ring opening
a—Distance between gasket and bolt circle
a_o—Distance from bolt circle to center of hub thickness in a hubbed flange
d_m—Mean diameter of hub in a hubbed flange
t—Thickness of hub in a hubbed flange
μ—Poisson's ratio

Hubbed Flanges—Variation of Flange Thickness and Fillet Radius

(Fig. 10 has been plotted from the values given in this table)

Flange Dimensions

$D = 16.35$ In. $b = 15.625$ In. Ave. Tensile Strength
$d = 10.9$ In. $g = 11.7$ In. of Material:
$t = 0.8$ In. $a = 1.9625$ In. $S = 318$ Lb per Sq In.

$$S_{Test} = \frac{S_r \text{ Ave.}}{\frac{1.2}{318}}$$

$$M = \frac{318}{S_{Test}} M_{Test}$$

R	T	M_{Test}	S_r Ave.	S_{Test}	M
$R = 0$	0.8	336	208	173	616
$R = 0$	0.8	376	170	142	845
$R = 0$	1.2	630	266	222	905
$R = 0$	1.2	571	194	162	1123
$R = 0$	1.6	1630	374	312	1665
$R = 0$	1.6	886	237	198	1428
$R = 0$	2.0	1849	221	184	3195
$R = 0$	2.0	1730	277	231	2385
$R = 1/4$	0.8	847	233	194	1390
$R = 1/4$	0.8	Broke	...	...	...
$R = 1/4$	1.2	906	213	178	1625
$R = 1/4$	1.2	847	185	154	1750
$R = 1/4$	1.6	1357	256	214	2020
$R = 1/4$	1.6	1670	233	194	2740
$R = 1/4$	2.0	1630	240	200	2590
$R = 1/4$	2.0	1571	229	191	2618
$R = 1/4$	2.0	1515	232	193	2493
$R = 1/4$	2.0	1945	240	200	3094
$R = 5/8$	1.2	1082	181	151	2280
$R = 5/8$	1.2	1300	282	235	1760
$R = 5/8$	2.0	2400	235	196	3895
$R = 5/8$	2.0	2310	219	183	4025
$R = 1$	1.2	1810	260	217	2658
$R = 1$	1.2	1340	187	156	2733
$R = 1$	2.0	2950	272	227	4140
$R = 1$	2.0	2670	234	195	4350

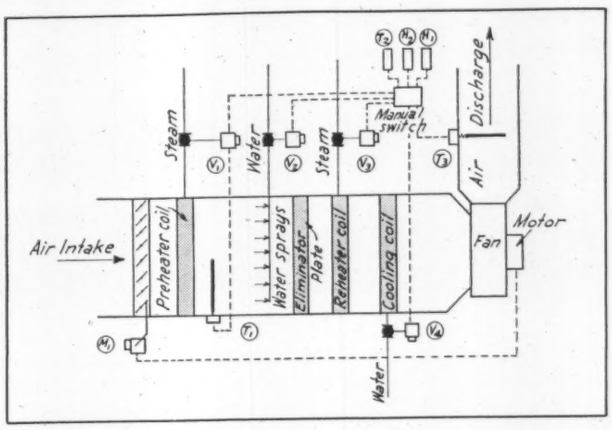
CONTROLS

By C. L. Ringquist*

Reference Sheet 7

Cooling, Dehumidifying, Ventilating and Humidifying Systems

All outside air is used in this system, which makes it an excellent one for the application of cold well or city water for cooling and dehumidifying purposes:



Cycle—Room thermostat T_2 is connected through manual summer-winter switch to modulating valve V_4 which regulates the amount of cold water passing through the cooling and dehumidifying coil, thus controlling the leaving air temperature from the coil. Room humidistat H_2 is also interconnected to V_4 through switch so that humidity requirements must also be satisfied before V_4 can operate to reduce water supply to coil.

For winter operation, duct thermostat T_1 controls action of modulating steam valve V_1 to maintain constant air temperature entering sprays, thus controlling moisture content of air under maximum conditions.

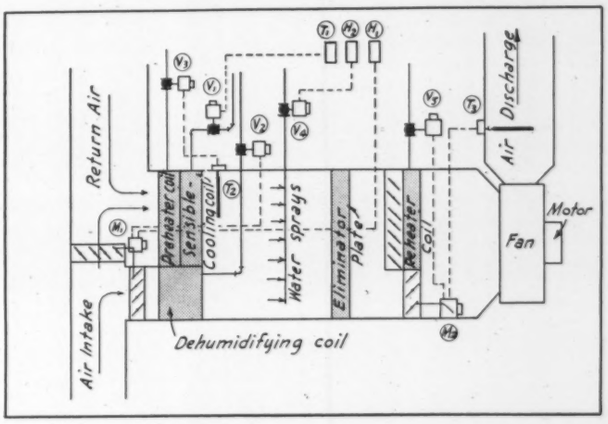
Humidistat H_1 interconnected to modulating water valve V_2 through summer-winter switch controls amount of water admitted to sprays in accordance with room humidity requirements.

Duct thermostat T_3 connected to modulating motor or diaphragm steam valve V_3 regulates amount of steam supplied reheating coil through V_3 to maintain constant discharge temperature from fan.

The summer-winter manual switch is interconnected with all controls to allow all summer controls to operate during the cooling and dehumidifying cycle and all winter controls to operate during the ventilating and humidifying cycle.

Damper motor M_1 in fan motor circuit allows outside air damper to open when fan is in operation and closes damper when fan is out of operation.

Another control system of this type is as follows:



Cycle—In summer, either cold well or city water or chilled water, depending upon amount of dehumidification required, is circulated through dehumidifying coil and warmer water through sensible cooling coil. If desired, some of return water from dehumidifying coil can be circulated through sensible cooling coil.

For winter operation, water supply to cooling coils is shut off. Because humidity maintained in winter is always lower than that maintained during summer, the face damper will always be closed, allowing all the outside air to pass through shunt damper and mix with recirculated air. This mixture then passes through preheating coil where temperature is increased in accordance with maximum humidity requirements, then through water sprays, moisture eliminator plates, reheater or bypass damper, into fan, and is discharged to duct system.

For summer operation, room humidistat H_1 controls amount of outside air passing through dehumidifying coil or shunt damper by means of damper motor M_1. M_1 is of the modulating type and operates in conjunction with modulating valve V_2 to close off supply of cold water to dehumidifying coil when all the outside air is passing through shunt damper. Room temperature is maintained by room thermostat T_1 controlling amount of water to sensible cooling coil through modulating valve V_1.

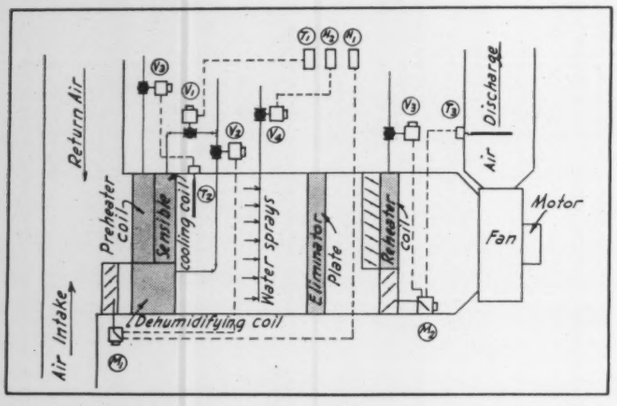
For winter operation, duct thermostat T_2 maintains constant temperature of air entering sprays by modulating valve V_3. Also, room humidistat H_2 controls room relative humidity by governing amount of water to sprays by throttling modulating valve V_4 in water supply line.

Duct thermostat T_3 acts to maintain constant discharge air temperature by controlling amount of air passing through reheater coil by means of modulating damper motor M_2. M_2 is equipped with auxiliary switch connected to two position valve V_5 which closes valve whenever all the air is passing through bypass damper, conserving steam and preventing "drift."

*Air Conditioning Department, The Trane Co., La Crosse, Wis.

Although data on automatic controls for heating, humidifying, dehumidifying, ventilating, cooling and complete air conditioning may be had from numerous sources, information on groups of controls applicable to various types of systems is not so readily available. The author has therefore diagrammed typical control layouts, with each of which is given an explanation of the control cycle. . . For the purpose of illustration, central fan coil types of systems are used; the control arrangements described are equally applicable to units built up to perform the same functions. . . Types of systems covered by this series include humidifying; ventilating; heating and ventilating; heating, ventilating and humidifying; cooling, dehumidifying and ventilating; cooling, dehumidifying, ventilating and humidifying; heating, ventilating, dehumidifying and cooling; heating, ventilating, dehumidifying, cooling and humidifying; and zone control systems.

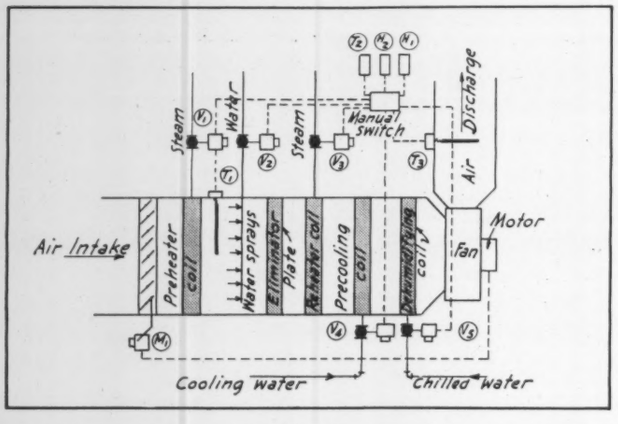
A slightly different arrangement of this system, generally used when the outside air requirements are small in proportion to the internal latent load:



Cycle—For cooling and dehumidifying, operation is much the same as with the system just described, except the outside and recirculated air are mixed before being drawn through the dehumidifying and sensible heat coils. Controls operate much the same, except that damper motor M_1 controls amount of the air mixture passing through the dehumidifying coil.

For winter, operation is exactly the same as described for previous system.

The following arrangement embodies a slightly different design to accomplish the desired results. For illustrative purposes a system using all outside air is shown; however, a system employing some recirculated air would be equally adaptable:



Cycle—For summer operation, outside air is drawn through outside air dampers, through the precooling coil in which the dry bulb temperature only is lowered, through the dehumidifying coil in which the moisture content as well as temperature is lowered, then into the fan which discharges the cool and dehumidified air to the duct system. In winter, air is drawn in through outside air dampers, preheated with the preheating coils to maintain a constant temperature to the sprays, where the moisture content of the air is raised, then through the moisture eliminator plates, through the reheater coil which maintains a constant discharge temperature, into the fan and out into the duct system.

For summer, room thermostat T_2 is interconnected to modulating valve V_5 in the chilled water line to the dehumidifying coil through a summer-winter manual switch. Room humidistat H_2 is also interconnected in the circuit so that both T_2 and H_2 must be satisfied before V_5 will throttle chilled water supply. Valve V_4 is so interconnected into the circuit so that upon the closing of V_5, the control from T_2 and H_2 will revert to modulating valve V_4.

For winter operation, duct thermostat T_1 controls modulating valve V_1 to govern steam to preheater coil in order to maintain constant air temperature entering sprays. Room humidistat H_1 controls water to humidifying sprays by means of modulating valve V_2, thus controlling amount of moisture added to the air. Duct thermostat T_3 controls amount of steam supplied to reheating coil by means of the throttling action of modulating valve V_3, thus maintaining a constant discharge temperature from the fan.

Damper motor M_1 is interconnected into fan motor circuit so that whenever motor is in operation the damper is open, but when motor stops, damper resumes closed position.

Note: In all of these illustrations, water has been used for cooling. A system using direct expansion coils and step controllers for regulating the amount of coil surface supplying cooling could be used equally as well with the designs shown.

[*Concluded from page* 176]

each flange was found by dividing the average modulus of rupture S_r (aver.) by 1.2. The values of the tensile strength S_{test} of the flanges are given in the tables. Since the values of the tensile strength differ from the basic tensile strength of 318 lb per sq in., the external moment M_{test} must be reduced to the basic value 318 lb per sq in., according to the relation:

$$M = \frac{318}{S_{test}} M_{test}$$

The values of M are given in the last column of each table. In the graphs contained in the report these values of M have been plotted against the various flange dimensions. All numerical values are in the inch-pound system.

Figs. 23, 24, 25, 26, 27, 28 and 29 show typical fractures of ring and hubbed flanges of various dimensions.

[*To be continued*]

Hubbed Flanges—Variation of Hub Thickness and Fillet Radius

(Fig. 13 has been plotted from the values given in this table)

Flange Dimensions

$D = 10.1$ In. $b = 9.4$ In. Ave. Tensile Strength of Material:
$d = 5.05$ In. $g = 5.57$ In.
$T = 1.0$ In. $a = 1.915$ In. $S = 318$ Lb per Sq In.

$$S_{Test} = \frac{S_r \text{ Ave.}}{1.2}$$

$$M = \frac{318}{S_{Test}} M_{Test}$$

R	t	M_{Test}	S_r Aver.	S_{Test}	M
$R = 0$	0.35	709	389	324	695
$R = 0$	0.35	546	328	273	636
$R = 0$	0.50	728	379	316	733
$R = 0$	0.50	776	374	312	791
$R = 0$	0.50	435	210	175	790
R = 0	0.50	406	321	268	481
$R = 0$	0.80	670	420	350	609
$R = 0$	0.80	776	429	358	690
R = ¼	0.35	709	367	306	737
$R = ¼$	0.35	700	403	336	662
$R = ¼$	0.50	747	348	290	819
$R = ¼$	0.50	728	370	308	752
$R = ¼$	0.80	1253	466	388	1028
$R = ¼$	0.80	1445	491	409	1123
$R = ½$	0.35	805	410	342	749
$R = ½$	0.35	900	491	409	700
$R = ½$	0.50	1032	437	364	902
$R = ½$	0.50	710	337	281	804
$R = ½$	0.80	1492	452	375	1265
$R = ½$	0.80	1570	509	424	1179
$R = ¾$	0.35	1110	376	313	1130
$R = ¾$	0.35	950	352	293	1032
$R = ¾$	0.50	1090	306	255	1360
$R = ¾$	0.50	1032	329	274	1200
$R = ¾$	0.80	1855	446	372	1585
$R = ¾$	0.80	1647	460	383	1368

Hubbed Flanges—Variation of Outside Flange Diameter

(Fig. 15 has been plotted from the values given in this table)

Outside Flange Diameter — Diameter of "Bolt Circle" = D-b = Constant

Flange Dimensions

$d = 5.05$ In. $g = 5.57$ In. Ave. Tensile Strength of Material:
$t = 0.65$ In. $\frac{D-b}{2} = 0.35$ In. $S = 318$ Lb per Sq In.
$T = 1.4$ In.
$R = 0$ In.

$$S_{Test} = \frac{S_r \text{ Ave.}}{1.2}$$

$$M = \frac{318}{S_{Test}} M_{Test}$$

D	$\frac{D-d}{2}$	b	a	M_{Test}	S_r Aver.	S_{Test}	M
8.25	1.6	7.55	0.99	624	266	222	895
8.25	1.6	7.55	0.99	445	176	147	963
9.1	2.025	8.40	1.415	750	287	239	998
9.1	2.025	8.40	1.415	708	303	252	893
11.75	3.35	11.05	2.74	1115	341	284	1250
11.75	3.35	11.05	2.74	714	238	198	1145

A New Feature—

Heating ✦ Piping and Air Conditioning Summary Sheets

How to Solve Heat Transfer Problems†

By **William Goodman***

Heat transfer problems may be divided into: (1) Condensing or vaporizing. (2) Parallel flow. (3) Counterflow. In problems in actual work, it is usually necessary to find the numerical answer of one of the following five quantities:

Class 1: A — Area of surface required
Class 2: H — Total heat transferred from one fluid to the other
Class 3: t_2 or t_2' — Final temperature of either the warm or cool fluid
Class 4: t_1 or t_1' — Initial temperature of either the warm or cool fluid
Class 5: G or G' — Required weight of either the warm or cool fluid

(Symbols with prime marks refer to the cool fluid, while symbols without prime marks always refer to the warm fluid.)

These five classes of problems can occur in problems of any one of the three main divisions.

HEAT TRANSFER FORMULAS

$$H = A \times U \times D_m \quad \ldots\ldots [1]$$

H = Total heat transferred, Btu per hr
U = Coefficient of heat transmission, Btu per hr per deg temp. diff. per sq ft of surface (determined experimentally)
A = Area of heat transfer surface, sq ft
D_m = Log mean temperature difference.

Formula 1 is satisfactory for finding the required area of heat transfer surface but it cannot be used to find the heat which a given amount of surface can transmit if only the initial temperatures of, say, the air and steam are known. For this purpose it is necessary to use the value of M in the fourth column of the table.

When one of the fluids is vaporizing or condensing,

$$M = \frac{U\,A}{G\,s} \quad \ldots\ldots [2]$$

G = Lb per hr of the one fluid whose temperature is changing. (Either G or G' should be used, depending upon which fluid is changing in temperature)
s = Specific heat of the one fluid whose temperature is changing. (Either s or s' should be used, depending upon which fluid is changing in temperature)

If M is known, it is possible, by the table, to find the ratio Ds/DL. With this known, the total heat transferred can be computed.

Problems in parallel flow are solved in the same way, with one exception, as follows:

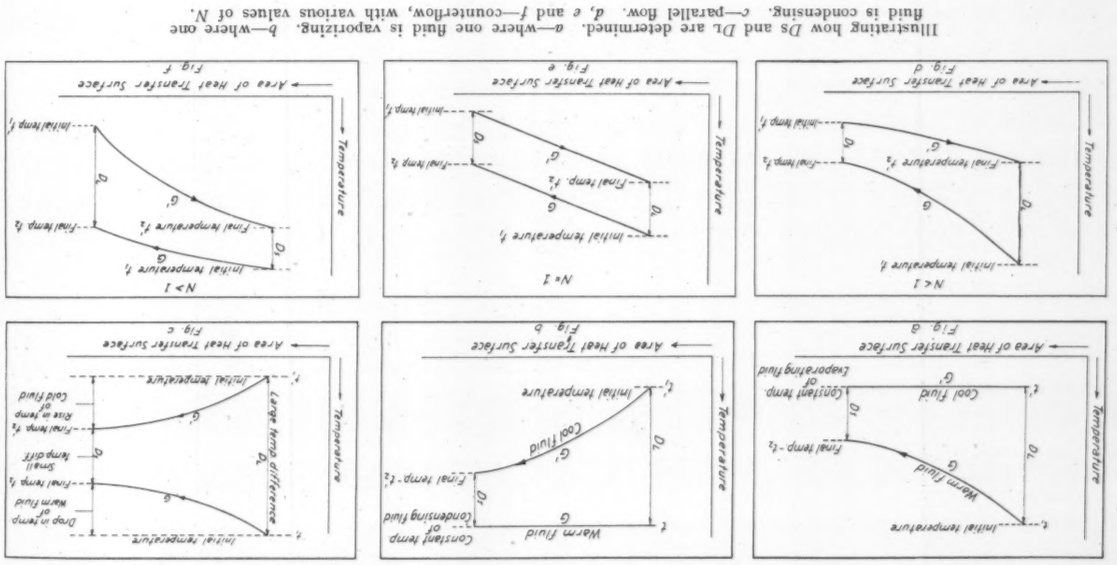
$$M = \frac{U\,A}{G\,s}\left(1 + \frac{G\,s}{G'\,s'}\right) \quad \ldots\ldots [3]$$

G = Weight of warm fluid, lb per hr
s = Specific heat of warm fluid
G' = Weight of cool fluid, lb per hr
s' = Specific heat of cool fluid

*The Trane Co., La Crosse, Wis. Member of Board of Consulting and Contributing Editors.

†Summarized from a series of three articles copyrighted by William Goodman published in HEATING, PIPING AND AIR CONDITIONING, January-February-March, 1937.

1



Illustrating how Ds and DL are determined. *a*—where one fluid is vaporizing. *b*—where one fluid is condensing. *c*—parallel flow. *d*, *e* and *f*—counterflow, with various values of N.

4

The first four of a new series of "summary sheets" are reproduced on this and the preceding page. The purpose of these sheets is to make available for quick reference for everyday use information needed in heating, piping and air conditioning work. . . . For complete information, refer to the original article from which these data are taken, as the purpose of these summaries is not to take the place of the article, but rather to put the essentials into convenient reference form. . . . The Editors will appreciate your suggesting what type of material you'd like presented in this way. . . . Address HEATING, PIPING AND AIR CONDITIONING, 6 North Michigan Avenue, Chicago, Ill.

Counterflow problems are handled in the same manner as parallel flow, except that

$$M = \frac{U A}{G s}\left(1 - \frac{G s}{G' s'}\right) \quad \text{.....[4]}$$

Problems in counterflow divide into three types depending upon the value of the ratio $G s/G' s'$ which may be designated by the symbol N. Thus,

$$N = \frac{G s}{G' s'} \quad \text{.....[5]}$$

The three types of counterflow problems are: (1) When N is less than one. (2) When N is equal to one. (3) When N is greater than one.

When N is less than one, the small temperature difference occurs at that end of the heat transfer apparatus where the warm fluid is *leaving*. When N is greater than one, the small temperature difference occurs at that end of the heat transfer apparatus where the warm fluid is *entering*. When N is equal to one, the initial, final, and mean temperature differences are all equal.

A problem that frequently occurs is that of finding the quantity of heat which a given coil can remove when only the initial temperatures and the weights of the two fluids—for example, air and water—are known. Once the total heat transferred from the air to the water is known, it is a relatively simple matter to compute the final temperature of either the air or the water. Under these conditions, the following formula can be used to compute the total heat H transferred from a warm to a cold fluid in counterflow.

$$H = \frac{L\,(t_1 - t_1')}{1 + \dfrac{L}{U A F}} \quad \text{.....[6]}$$

$F = D_M/D_L$
$L =$ Either $G s$ or $G' s'$; whichever is larger.

The first step in using Formula 6 is to find M by means of Formula 4. Then the corresponding value of D_M/D_L can be obtained from the table. This will be the value of F.

AN ILLUSTRATIVE EXAMPLE

A steam coil having an area of 150 sq ft is to be used to heat 6000 cfm of air. The value of U is 13 Btu. The temperature of the condensing steam is 220 deg and the initial temperature of the air is 40 deg. Find the final temperature of the air and the total heat transferred by the coil.

$$G's' = 6000 \times (60/13.3) \times 0.24 = 6510$$

(13.3 cu ft is volume of 1 lb of air at 70 F; 0.24 = specific heat of air)

$$M = UA/G' s' = (13 \times 150)\ /6510 = 0.30.$$

Referring to Col. 4 of the table for $M = 0.30$, find in Col. 1 $D_S/D_L = 0.74$.

$$D_L = 220 - 40 = 180 \text{ deg}$$
$$D_S = 180 \times 0.74 = 133 \text{ deg}$$

Referring to Fig. b, final air temperature

$$t_2' = t_2 - D_S = 220 - 133 = 87 \text{deg}$$
$$H = G' s' \ (t_2' - t_1')$$

Heat removed = 6510 (87 — 40) = 306,000 Btu per hr

Data For Solving Heat Transfer Problems

$\frac{D_S}{D_L}$	$\frac{D_M}{D_L}$	$\frac{D_S}{D_M}$	M	$\frac{D_S}{D_L}$	$\frac{D_M}{D_L}$	$\frac{D_S}{D_M}$	M
Col. 1	Col. 2	Col. 3	Col. 4	Col. 1	Col. 2	Col. 3	Col. 4
				0.50	0.721	0.693	0.693
0.01	0.215	0.046	4.605	.51	.728	.701	.674
.02	.251	.080	3.912	.52	.734	.708	.654
.03	.277	.109	3.507	.53	.740	.716	.635
.04	.298	.135	3.219	.54	.746	.724	.616
0.05	0.317	0.158	2.996	0.55	0.753	0.731	0.598
.06	.334	.180	2.814	.56	.759	.738	.580
.07	.350	.200	2.660	.57	.765	.745	.562
.08	.364	.219	2.526	.58	.771	.752	.545
.09	.378	.238	2.408	.59	.777	.759	.528
0.10	0.391	0.256	2.303	0.60	0.783	0.767	0.511
.11	.403	.273	2.207	.61	.789	.773	.494
.12	.415	.289	2.120	.62	.795	.780	.478
.13	.427	.305	2.040	.63	.801	.786	.462
.14	.438	.320	1.966	.64	.806	.794	.447
0.15	0.448	0.335	1.898	0.65	0.813	0.800	0.431
.16	.458	.349	1.833	.66	.818	.807	.415
.17	.469	.363	1.772	.67	.823	.814	.401
.18	.478	.377	1.716	.68	.829	.820	.386
.19	.488	.390	1.660	.69	.836	.826	.371
0.20	0.497	0.402	1.609	0.70	0.840	0.833	0.357
.21	.506	.415	1.561	.71	.848	.838	.342
.22	.515	.427	1.514	.72	.852	.845	.329
.23	.524	.439	1.470	.73	.858	.851	.315
.24	.533	.451	1.427	.74	.864	.856	.301
0.25	0.541	0.462	1.386	0.75	0.870	0.862	0.287
.26	.549	.473	1.347	.76	.874	.870	.275
.27	.558	.484	1.309	.77	.879	.876	.262
.28	.566	.495	1.273	.78	.886	.881	.248
.29	.574	.506	1.238	.79	.890	.887	.236
0.30	0.582	0.516	1.204	0.80	0.896	0.893	0.223
.31	.589	.526	1.171	.81	.902	.899	.211
.32	.597	.536	1.139	.82	.907	.904	.198
.33	.604	.546	1.109	.83	.913	.910	.186
.34	.612	.556	1.079	.84	.918	.915	.174
0.35	0.619	0.565	1.050	0.85	0.923	0.921	0.163
.36	.626	.575	1.022	.86	.928	.927	.151
.37	.634	.584	.994	.87	.934	.932	.139
.38	.641	.593	.968	.88	.939	.938	.128
.39	.648	.602	.942	.89	.944	.943	.117
0.40	0.655	0.611	0.916	0.90	0.949	0.948	0.105
.41	.662	.620	.892	.91	.955	.953	.094
.42	.669	.628	.868	.92	.959	.959	.083
.43	.675	.637	.844	.93	.964	.965	.073
.44	.682	.645	.821	.94	.970	.969	.062
0.45	0.689	0.653	0.798	0.95	0.975	0.974	0.051
.46	.695	.662	.777	.96	.979	.980	.041
.47	.702	.670	.755	.97	.986	.984	.030
.48	.709	.677	.734	.98	.991	.989	.020
.49	.715	.686	.713	.99	.995	.995	.010

D_L=large temperature difference, and D_S=small temperature difference used in determining log mean temperature difference, D_M. See text for the various formulas for M.

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The Nature of Noise in Ventilating Systems and Methods for Its Elimination

By J. S. Parkinson* (*NON-MEMBER*), Manville, N. J.

NOISE control is becoming increasingly important in the design of ventilating and air conditioning systems. This is partly because conditioning is being used in office and residential locations where the requirements for noise control are more rigid, and partly because of an increasing noise consciousness on the part of the buying public. There is, however, little accurate engineering information available. The following discussion presents certain definite facts which may be used as a foundation and indicates where further work must be done. It is presented only as a progress report.

In cooperation with the A.S.H.V.E. Technical Advisory Committee on Sound in Relation to Heating and Ventilation, the author has prepared a table of typical noise levels as they are encountered in various room locations. These values are presented in Table 1. It has been suggested that as a temporary procedure the equipment noise level should not be greater than the background noise level already existing in the space. This means that when the equipment noise is present the total noise level will be increased 3 db (decibels). In cases where the equipment noise must be practically eliminated, it will be necessary to reduce such noise to a point about 10 db below the background level. Such a procedure disregards the effect of frequency variations, but since the problem of annoyance versus frequency distribution is so complex, no simple specification can be set up to cover this point. In general, though, it may be said that the loudness level at any frequency should not be greater than the background noise, and at the high frequencies the loudness level of the equipment noise should if possible be materially lower.

Two curves (due to Hale Sabine) are shown in Fig. 1 which may be called *equal annoyance contours*. Since there are no exact data on the annoying or disturbing effect of various frequencies, such a curve can only be an estimate. The general form of these curves is, however, substantiated by numerous tests. The curves are drawn so as to pass through a loudness level for each frequency which is equally as annoying as any other point on the curve. Thus it may be estimated that a loudness level of 40 db at 5000 cycles is just as annoying as one of 55 db at 1000 cycles, and that at 100 cycles it requires a loudness level of 68 db to be as annoying. The important fact to observe is that annoyance increases with frequency, and levels which are not disturbing at low frequencies may in consequence become troublesome at high frequencies.

*Engr. in Charge, Acoustical Engrg. Section, Johns-Manville.

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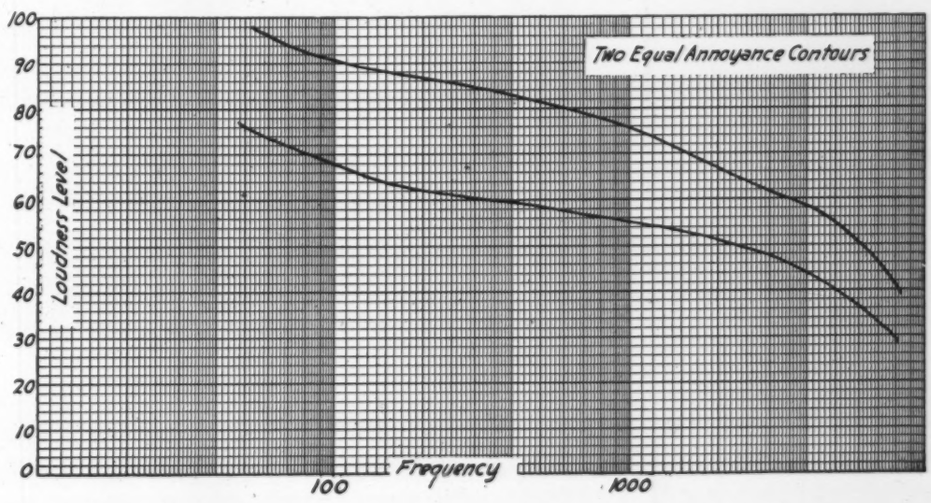


Fig. 1 — Relation between frequency and degree of annoyance for loudness levels of 55 db and 75 db (estimated)

Characteristics of Noise in Ventilating Systems

In order to meet these requirements it is necessary to know the nature and source of the noise caused by ventilating systems. It must be determined where these sounds originate, how they are transmitted, and what measures can be taken to eliminate them. It is not the purpose of this paper to discuss the mechanical design of equipment in other than general terms, since this is a problem which the manufacturer is better equipped to handle than the acoustical engineer.

The noise encountered in ventilating systems has three general sources, the motor, the fan, and the air itself. The motor generates frequencies which are related to the rotational speed, and the electrical frequency. The fan may generate sounds which are a function of its rotational frequency, and will also generate frequencies which are multiples of the blade frequency. The air moving past roughnesses or obstructions in the duct is set into vortices which give off high frequency sound. There may also be noise generated at the outlet which results from the abrupt change in dimensions or from faulty grille design.

Usually of particular interest is the noise at a point a

Table 1—Typical Noise Levels in Various Locations

Room Locations	Loudness Level in Decibels to be Anticipated[a]		
	Min.	Representative	Max.
Sound Film Studios	10	14	20
Radio Broadcasting Studios	10	14	20
Planetarium	15	20	25
Residence Apartments, etc.	25	35	40
Theaters—Legitimate	25	30	35
Theaters—Motion Picture	30	35	40
Auditoriums, Concert Halls, etc.	25	30	40
Churches	25	30	35
Executive Offices—Treated Private Offices	25	33	40
Private Offices—Untreated	35	45	50
General Offices	45	55	60
Hospitals	25	40	55
Class Rooms	30	35	45
Libraries, Museums, Art Galleries	30	40	45
Public Building—Court Houses, Post Offices, etc.	45	55	60
Small Stores	40	50	60
Upper Floors Department Stores	40	50	55
Stores—General—including Main Floor Dept. Stores	50	60	70
Hotel Dining Rooms	40	50	60
Restaurants and Cafeterias	50	60	70
Banking Rooms	50	55	60
Factories	60	70	80
Office Machine Rooms	60	70	80
Vehicular Noise			
Railroad Coach	60[b]	70	80
Pullman Car	55[b]	65	75
Automobile	50	65	80
Vehicular Tunnel	75	85	95
Airplane	80	85	100

[a]It is assumed that if equipment noise alone is not greater than these levels of background noise at any frequency band, results will be commercially satisfactory. When both are heard together, an increase in total level of 3 db can be anticipated.

[b]For train standing in station a level of about 45 db is the maximum which can ordinarily be tolerated.

Table 2—Loudness Level in Decibels at Various Speed Ranges

Frequency	700-780 fpm	1234-1570 fpm	1760-2085 fpm	2580-3440 fpm
Total	59	77	59	74
0-64	5	20	14	35
64-128	19	41	24	45
128-256	58	72	58	69
256-512	53	75	53	73
512-1024	47	66	45	61
1024-2048	45	65	43	58
2048-4096	42	63	42	58

few feet from the outlet of the duct where it enters the room. Measurements in various locations have shown that this loudness level may vary over a wide range—from 50 to 90 db above 10^{-16} watts/sq cm. A fairly representative range for untreated systems is from 55 to 75 db. In a small experimental system set up at the laboratory, consisting of a large blower (63 forward curved blades) connected to about 20 ft of 18 in. x 18 in. galvanized iron duct, the frequency analyses for different speeds gave the loudness levels shown in Table 2.

In order to change air speed the opening at the intake was constricted by a circular insulating board baffle and two different size pulleys were used on the fan. The baffle was used in making the measurements reported in the first two columns. The pulley diameter was 22 in. in column one and column three, 12 in. in column two and column four.

Two more ventilating systems were investigated under actual conditions of use. System A was an exhaust system connected to the blower through about 30 ft of 6 in. x 20 in. duct, opening into a small office through an opening in the side. The motor in this system was definitely noisy. System B was a pressure system opening into a small office through about 30 ft of 10 in. diameter round duct with a right angle bend at the opening and three more such bends between the opening and the fan. These systems were both sufficiently noisy to cause complaints. Air speeds were in the normal range for such installations. The frequency distributions were as follows, expressed in terms of loudness level:

	0-64	64-128	128-256	256-512	512-1024	1024-2048	2048-4096	Total
System A	51	55	72	65	63	55	51	73
System B	62	57	69	66	55	43	36	71

In four cases out of these six the frequency band from 128 to 256 cycles contained the highest amount of energy. In the remaining cases the next highest frequency band—from 256 to 512 cycles—became more prominent as the air speed was increased. In every system measured during the course of these experiments the major part of the energy lay in this range. Therefore, if a reduction in the total loudness level is desired, a reduction in this range of frequencies is the first essential. Since decibel levels must be added logarithmically to arrive at a total, even a large decibel reduction in a high frequency band will make only a small fraction of a decibel change in the total loudness level. On the other hand, a reduction in one of the higher bands may make a very appreciable difference in the annoyance factor. In general, it will make a difference whether a noise level guarantee is involved. Such guarantees are almost invariably based on the total noise level, and in such a case the low frequency range must receive first attention. If no guarantee has been made, and it is desired merely to make the noise less disturbing, a treatment to reduce the high frequencies may be adequate. This will be discussed more

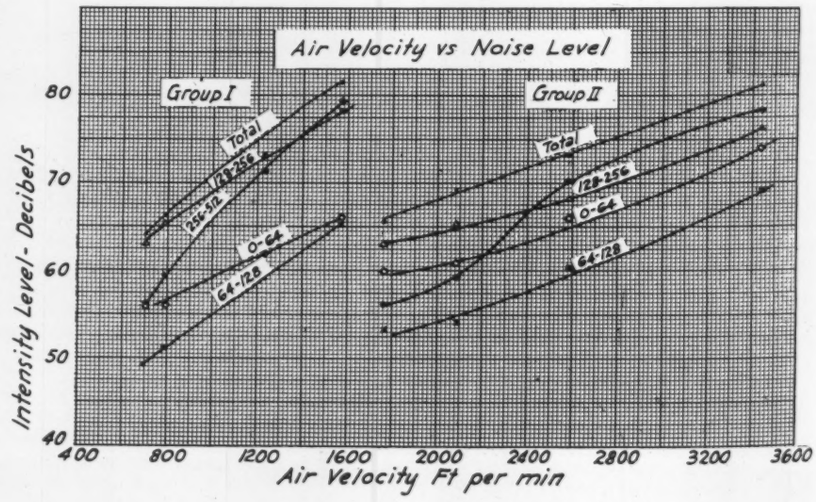


Fig. 2 — Increase in intensity level with increase in air speed. The range of fan speeds is the same in both groups, but group I used an intake restriction where group 2 did not

in detail when the effect of sound absorbent materials is considered.

Table 2 shows certain useful facts about the relation between noise and air speed. When the air speed was increased by decreasing the pulley size and hence increasing the fan speed, the noise level increased. Compare column 1 with 2, and 3 with 4. On the other hand, increasing air speed by increasing the size of the intake opening scarcely affected the noise level and actually decreased it in some cases. This can be seen by comparing columns 1 with 3, and 2 with 4. It is probable that the constriction placed over the intake interfered with the uniformity of air flow into the blades, thus increasing the noise level instead of decreasing it. These deductions corroborate a fact which has been observed elsewhere, that noise level is a function of fan speed rather than of air speed.

Additional data on the variation of noise level with air speed and fan speed are presented in Figs. 2 and 3. In this case the ordinates are intensity levels in decibels without correction to the ear threshold since the variations of the level with air speed and fan speed were of sole interest. See also Table 3.

In this case the fan speed was the same in both groups. The increases were obtained first by increasing the motor speed and then by decreasing the pulley diameter. Here also the levels are related directly to fan speed but not to air speed. The frequency range may be divided readily into two groups. The frequencies below 512 cycles exhibit a fairly constant relation between fan speed and noise level with the exception of the 256-512 band in group one. This appears to belong more closely with the high frequency group. Those above 512 cycles also exhibit a fairly constant increase in noise level with fan speed, but the slopes of the curves are different from those in the low frequency group. This is interpreted to mean that the source of noise in the two frequency ranges is different. As suggested, it is probable that the upper frequencies are largely created by air turbulence.

Methods of Eliminating Noise

There are a number of methods of preventing noise in ventilating systems, most of which are familiar. Vibrations can be prevented from telephoning through the walls of a duct by using suitable flexible connections between the fan and the duct. The fan and motor should be separated from the building structure by vibration insulating mounting. Fan speeds should be kept as low as possible, and equipment should be well balanced and free from excessive vibration. Large duct sections should be braced to avoid resonance and diaphragmatic response. Construction should be such as to avoid unnecessary air turbulence. All these are precautions which any competent engineer will observe.

Table 3—Increase in Intensity Level at Various Frequency Bands Expressed in Decibels per Velocity Increase of 100 fpm

	With Constriction on Intake	Without Constriction on Intake
Total	2.0 db	0.92 db
0.64	1.15	0.84
64-128	1.85	0.95
128-256	1.85	0.78
256-512	2.64	1.31
512-1024	2.75	1.37
1024-2048	2.94	1.31
2048-4096	3.13	1.38

But there are many cases where even with all precautions the system is still unsatisfactory. In such cases sound absorbent lining placed inside the duct can be used with good effect. In choosing such a lining, a number of factors must be considered. The most obvious is sound absorbing efficiency, especially in the range below 500 cycles. Nearly all acoustical materials display high efficiency at the upper frequencies, but special design is necessary to obtain efficiency in the low frequency range. If a porous material is used, it must possess a fairly high flow resistance.

In addition to a good absorption-frequency characteristic, the material must be resistant to moisture and vermin, non-combustible, and must offer little frictional resistance to the passage of air across its surface.

Theory of Sound Transmission Through Lined Ducts

A sound wave generated within a three dimensional closed space will undergo reflections at a rate equal to

$$n = \frac{vs}{4V} \qquad (1)$$

where n = number of reflections per second
s = surface area of enclosed space
V = volume of space
v = velocity of sound

The energy after n reflections will be

$$E = E_o(1-\alpha)^n \qquad (2)$$

where E_o = the initial energy
α = the absorption coefficient of the reflecting surface.

If sound traveling down a duct is considered as suffering a similar series of

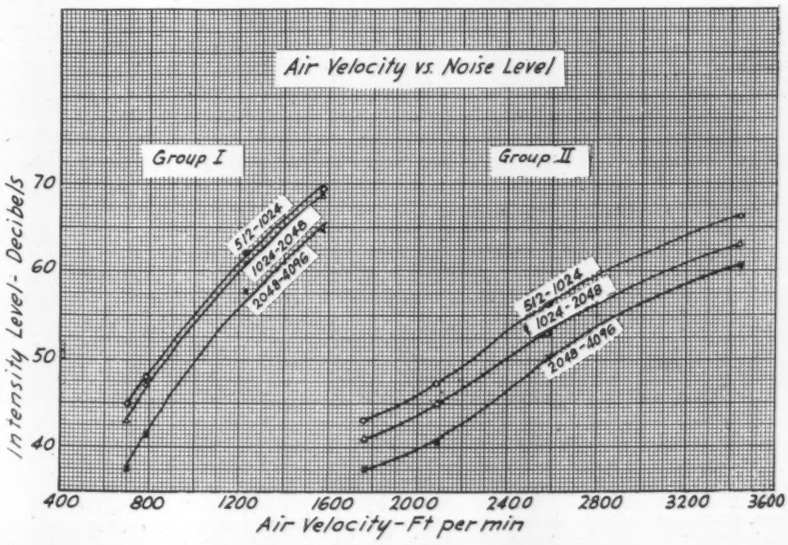


Fig. 3—Increase in intensity level with increase in air speed. The range of fan speeds is the same in both groups, but group 1 used an intake restriction where group 2 did not

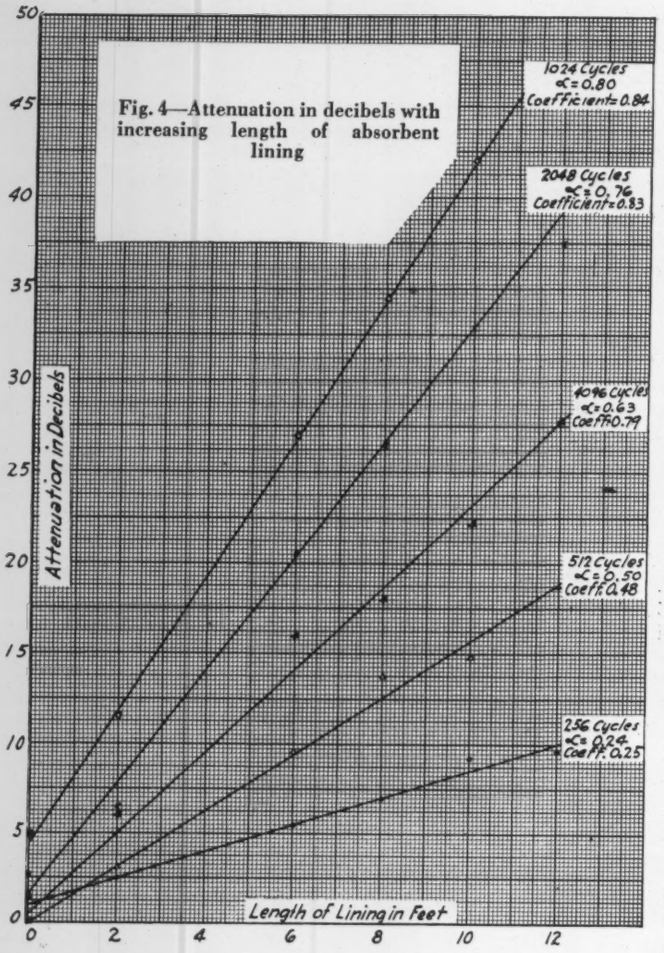


Fig. 4—Attenuation in decibels with increasing length of absorbent lining

reflections, the analogue to the quantity $4V/s$, which represents the mean free path in a three dimensional space, is for the two dimensional case, $\frac{\pi a}{p}$, and

$$n = \frac{v\,p}{\pi\,a}$$

where p = the perimeter and
a = the cross sectional area.

The energy absorbed in unit time in a three dimensional space is inversely proportional to the mean free path. On this theory, in a duct the energy absorbed in unit time (or, equivalently, in unit length) will be proportional to p/a or inversely proportional to the hydraulic radius. If the energy equation is written in a form suitable to express reductions, substituting for n:

$$\frac{E}{E_o} = \left(1 - \alpha\right)^{\frac{v\,p}{\pi\,a}} \tag{3}$$

and therefore

$$\log \frac{E_o}{E_1} = -\frac{v\,p}{\pi\,a} \log\,(1 - \alpha) \tag{4}$$

or Energy reduction in Decibels

$$R = -\frac{Kp}{a} \log\,(1 - \alpha), \text{ for unit length,} \tag{5}$$

where K is the experimental constant, as yet undetermined. Some experimental constant must be introduced to allow for the difference between the absorption coefficient as measured for random incidence in the reverberation chamber and the coefficient which must be used for waves traveling parallel to the surface of the material. This and the question of transverse flow are both involved.

In ducts whose cross sectional dimensions are of the same order or smaller than the wave length, the random reflection hitherto assumed is more likely to be replaced by a plane wave form travelling down the length of the duct. In such a case the effect of the lining would be to strip energy from the edges of the wave. There will then be a flow of energy transversely across the face of the wave depending on the pressure gradient produced by the absorption of energy at the edges.[1]

No attempt will be made here to deduce a complete mathematical theory for this case, but certain facts are apparent. The energy absorbed from the edges of a plane wave will be governed considerably by the ratio of the wave area in contact with the duct walls to the total area of the wave. This will be again expressed by p/a. The energy ratio will be again a direct function of the absorbing efficiency with the length as an exponential. The question remains, however, as to whether a change in the experimental constant will take care of variations in the transverse flow with different absorbers and different shapes, or whether some power of the quantity p/a must be used. This question will be discussed further as the course of the experiments are described.

Experimental Data

Single Frequency Tones

These experiments employed a loud speaker actuated by a vacuum tube oscillator as a sound source. A warble of ±20 cycles was applied to the test tone. The length of test duct was about 10 ft, terminating in a right angle bend at the point where the duct opened into the test room. Dimensions of the duct were 18 in. x 18 in. One microphone was placed at the beginning of the test length and a second at the outlet. Each was arranged in such a way that a number of positions could be taken to average out variations in the wave pattern. In making the experiments, succeeding sections 2 ft long were lined with absorbent material starting at the end nearest the source until the total length had been lined. In some cases the unlined duct itself showed an appreciable reduction.

A typical set of curves obtained from this test are illustrated in Fig. 4. The sound absorbent used had an absorption-frequency characteristic peaked at 1024 cycles. These curves demonstrated several useful facts. First, the assumption of a uniform decibel reduction per unit length is substantiated. Second, the reductions are uniform with length at all frequencies, and the slopes vary only with the absorption coefficient. This last fact was deduced as follows: Using the formula given under (5), K was found to be —1.95 for one frequency. As indicated in Fig. 4, the coefficients obtained at other frequencies from the slopes of the curve using this constant agree well with reverberation chamber coefficients. These experiments were repeated with a number of different types of linings, and the conclusions verified.

The next problem was to check the assumptions of the formula for different duct sizes. The above experiments dealt only with the single duct 18 in. x 18 in. Data were collected from other laboratories as well as for these experiments, and the results are shown in Table 4,

[1]Some Data on a Room Designed for Free Field Measurements, by E. H. Bedell (*Journal of the Acoustical Society of America*, October, 1936).

Table 4—Decibel Reductions for Various Size Ducts

Duct Size		Frequency	Measured Reduction per Foot	Calculated Reduction per Ft Formula (6)
18 in. x 18	in.	256	0.62 db	0.34 db
18 in. x 18	in.	512	1.55	1.37
18 in. x 18	in.	1024	3.64	3.85
18 in. x 18	in.	2048	3.13	3.71
18 in. x 18	in.	4096	2.23	2.89
18 in. x 18	in.	256	0.44	0.31
18 in. x 18	in.	512	1.15	1.73
18 in. x 18	in.	1024	2.36	2.76
18 in. x 18	in.	2048	3.29	2.36
18 in. x 18	in.	4096	2.34	2.15
7⅞ in. x 17	in.	256	1.10	0.39
7⅞ in. x 17	in.	512	1.50	2.19
7⅞ in. x 17	in.	1024	3.65	3.48
7⅞ in. x 17	in.	2048	4.52	2.97
3¾ in. x 17	in.	128	0.13	0.28
3⅜ in. x 17	in.	256	0.94	0.54
3⅜ in. x 17	in.	512	3.11	3.03
3⅜ in. x 17	in.	1024	4.20	4.81
3⅜ in. x 17	in.	2048	7.76	4.11
8 in. x 10	in.	1000	4.75	4.62
8 in. x 10	in.	1000	5.62	6.61
8 in. x 10	in.	512	1.88	1.98
6½ in. x 6½	in.	400	1.2	1.39
6½ in. x 6½	in.	1000	4.56	6.19
6 in. x 6	in.	512	2.56	2.92
6 in. x 6	in.	1024	4.00	4.64

column 3. Again all tests were made using single frequency tones, usually with a warble applied.

It was found that the original formula (5) gave results which were considerably too large for small duct sizes and large perimeters. Increasing the exponent of p does not correct this difficulty, for in any case where the exponent of p differs from the exponent of a an optimum duct shape will be found which is a better absorber than any other shape either larger or smaller, a result which appears untenable. The procedure finally used was to vary the exponent of the ratio (p/a) until a value was found which satisfied all conditions. Using this value a new experimental constant was computed. The best correlation to the data was found for exponents varying from 0.50 to 0.55, but since the experimental deviation was still considerably larger than the deviation produced by altering the exponent of (p/a) slightly, a value of 0.50 was finally selected. The formula then became:

$$R = -2.84\, l \left(\frac{p}{a} \right)^{\frac{1}{2}} \log\ (1-\alpha) \qquad (6)$$

(introducing the length factor l)

The data in column 4 of Table 4 are calculated from this formula (6) and the absorption coefficients of the materials as published.

While there are variations in many cases between measured and computed values there is no consistent trend in these variations, and the average error is less than 0.02 db. It therefore is possible that the variations observed are variations in absorbing efficiency or errors in measurement. For example, no account has been taken of the absorbing power of the duct itself when used in combination with a sound absorbent lining. There are many cases where such lining displays quite different properties when cemented to a sheet metal surface.

Elementary considerations would lead one to expect a constant much larger than 2.84, and it would be of interest to investigate this point. Since, however, the principal object of this work was to involve a simple working formula for engineering use, it has not as yet been possible to do this.

The formula in its present form indicates several facts of fundamental importance. As long as the shape factor is constant, the larger the duct, the smaller will be the attenuation. The attenuation increases more and more rapidly with increasing values of α. It is therefore desirable to use absorbing materials having as high a coefficient as possible. For example, in any given duct a material having 75 per cent absorption will produce three times as much attenuation per lineal foot as one having a coefficient of 37½ per cent. Some of these conclusions are not new, but experimental verification has been lacking.

Fan and Blower Noise

The final step in these experiments was to apply the conclusions obtained above to actual ventilating system noise. For this purpose a new test set-up was constructed with a large blower (63 forward curved blades, capable of delivering 6,000 cfm at 200 rpm) in one room, a length of test duct leading through a carefully sound insulated wall into another room, and microphone at the outlet of the duct in the receiving room. The fan was of the multi-blade type, driven by a 5 hp electric motor. Both fan and motor were mounted on a vibration insulating platform to prevent direct communication through the floor. The fan was connected via a 39 in. adapter to the test duct, which was 18 in. x 18 in. and 14 ft long. The air was taken in and exhausted through large doors 3 ft 6 in. x 7 ft 0 in. The duct itself was wrapped with 2 in. of rock wool blanket to avoid transmission through the walls into the receiving room. The microphone was placed in the test room at several positions within 30 in. of the end of the duct, but in no case beyond the plane of the end of the duct. Several tests were made to determine whether background noise or noise transmitted from the fan room by other means than through the duct could be interpreted in the results. In one case the duct was sealed off at a point before it entered the test room with an air tight seal. This procedure reduced the noise at all frequency bands to a point well below the levels measured during test. It appears safe to assume, therefore, that whatever sound reached the test room came through the duct. Transmission through the wall of the duct was prevented by a flexible canvas connection between fan and adapter section.

Air velocity measurements were made with a Pitot tube and inclined water gage. Where necessary this gage was checked by a Wahlen gage. All air velocities given were the weighted average of seven Pitot positions taken across the duct. The Pitot tube was placed about five diameters from the outlet and six to seven diameters from the fan.

The noise analysis of this blower unit has already been given in Table 2 for various speeds. Typical reductions for the various frequency bands with succeeding lengths of lining material are given in Table 5.

It will be found upon analysis that the formula given holds fairly well for the first few feet, but beyond that point the reductions are less than expected. At the low frequencies this effect is less pronounced, but at the high frequencies the principal reduction occurs in the first few feet of lining.

In order to investigate this point the microphone was connected to the interior of the duct by a rubber tube

Table 5—Reductions in Noise Level Produced by Various Lengths of Duct Lining

Frequency Band	Reverberation Chamber Absorption Coefficient of Material	Large Blower—Air Velocities Averaged from 2600 to 3700 fpm 2 Ft	4 Ft	6 Ft	8 Ft
0-64.	...	2.1 db	4.0 db	6.2 db	...
64-128	0.08	1.5	1.0	3.2	3.2 db
128-256	0.33	2.2	1.9	3.9	3.5
256-512	0.56	3.2	5.0	6.6	7.7
512-1024	0.67	5.3	8.5	9.3	9.6
1024-2048	0 67	8.5	10.1	9.7	11.0
2048-4096	0.64	6.1	7.8	6.6	7.9
Total	...	1.5	2.6	3.1	4.0

Table 6—Reductions in Noise Level Produced by Additional Lengths of Duct Lining

Frequency	4 Ft Added	6 Ft Added	8 Ft Added	10 Ft Added
0-64	4.5 db	5.7 db	7.7 db	7.0 db
64-128	5.7	7.3	9.7	8.3
128-256	3.1	4.3	5.2	5.5
256-512	3.1	4.3	6.9	6.5
512-1024	3.5	5.7	5.3	5.7
1024-2048	7.9	7.1	8.7	10.1
2048-4096	7.4	7.6	7.9	7.9
4096-8192	11.9	11.9	12.9	11.8
	4.4	5.4	6.4	7.7

at various points along its length. Starting at a point where there was only one foot of lining material between the tube position and the blower, successive positions were taken along the duct so that an increasing length of lining material intervened. The differences between the base reading with 1 ft of lining effective and varying increments of length are given in Table 6. (Same material as in Table 5.)

At the high frequencies, the noise level appears to drop to a certain constant level after which further lengths of lining have little effect. To some extent this effect is observable at the low frequencies, but not to such a pronounced degree. The total noise reading, which is determined almost entirely by the low frequencies, displays this tendency only slightly. Since the experiments on single frequency tones all show a uniformly increasing decibel attenuation with increasing length, the explanation must be related to the conditions of this particular test. If the lining attenuates uniform sounds originating at the fan, the only possible explanation is to assume another source of noise contributing to the level at the microphone. The experiments previously described indicate that when the air is blocked off, there is little noise present. This process of elimination indicates that the air itself must be generating new sound as it passes through the duct.

If this is the case, it might be supposed that the air velocity would be a controlling factor, and that frictional effects at the surface of the lining material would be important. The early experiments were run at high air speeds. Accordingly experiments were tried over a lower range of air speeds from 700 fpm to 2100 fpm. In all cases the results were of the same order. Measurements were likewise made of the frictional resistance of the lining material. It was found that this material increased resistance by about 19 per cent more than the unlined duct, an increase which does not appear sufficient to account for the results.

It was concluded that this non-linear reduction was characteristic of the system. The next step was to test other systems, for comparison purposes. Two such systems were investigated. These were exhaust ducts leading from other laboratory spaces, operating at a rather low air velocity. One system consisted of an 11 in. diameter round duct with a run of about 20 ft to the fan, containing three right angle bends. The other system consisted of a 6¾ in. diameter round duct, having a run of about 40 ft, with three right angle bends. Results on both systems were similar. Those obtained for the first system are presented here as typical. (A different lining material was used, so the results are of a somewhat different order.)

Table 7—Reductions in Noise Level Produced by Various Lengths of Duct Lining

Frequency	Absorption Coefficient of Material	62 in. lining	124 in. lining	124 in. lining and bend
0-64	....	0.6 db	1.6 db	2.6 db
64-128	0.10	0.6	2.6	3.2
128-256	0.13	1.8	4.3	4.7
256-512	0.30	4.2	8.6	8.2
512-1024	0.76	17.3	26.1	29.9
1024-2048	0.84	24.8	28.8	28.8
2048-4096	0.80	14.7	19.7	20.3

Up to 512 cycles increasing length of lining produces an approximately proportional increase in attenuation, but above this frequency the same non-linearity is observed as in the original experimental system. In all systems tested, this effect has appeared.

Sound absorbing treatment should evidently be placed at the outlet, since only in this way can it act upon sound generated as the air passes through the duct. For high frequency correction any reasonably efficient material is adequate and a length corresponding to ten diameters is probably ample. For low frequency correction and reductions in total loudness level a prediction can be based on the formula (6), but a factor of safety will be necessary until the effect of noise generated along the duct itself upon these lower frequencies is evaluated.

Since most sound absorbent materials of a porous nature are relatively inefficient at the low frequencies, other methods of sound elimination have received attention. This work has not progressed to a point where it can be reported, but it has already been found possible to produce many times the attenuation for a given length at low frequencies by specially designed wave traps and filters as compared with what can be obtained with simple lining material as ordinarily used.

Future Work

As stated earlier, this work can only be regarded as a progress report. Among the problems which still require solution are (1) a final quantitative answer to the question of noise generated within the duct, (2) the effect of bends and splitters (3) evaluation of the basis for the experimental constant in the formula, and (4) effect of grilles and standard outlet openings on the noise level. It is hoped that the discussion may inspire enough interest so that other investigators may see fit to carry on the work.

Investigations on the Exchanges of Energy Between the Body and Its Environment

By Charles Sheard,* Ph.D. and Marvin M. D. Williams,** Ph.D. (*NON-MEMBERS*) Rochester, Minn.

THE constant internal temperature of the body is the result of the balance between the production of heat in the body and the loss of heat from the body. This constancy of internal temperature is maintained in the face of rather wide variations in the production of heat and in the environmental conditions. It has been shown by various investigators[1] that approximately 75 per cent of the total elimination of heat from the body is by radiation, conduction and convection from the skin and about 25 per cent by the vaporization of water from the skin and lungs when activities, short of physical labor, are carried on under comfortable environmental conditions. The necessity of the additional clothing in cold weather, on the one hand, in order to prevent an excess loss of heat from the body and, on the other hand, the inadequacy of the processes of radiation, convection and conduction to produce sufficient dissipation of heat in hot weather without increased vaporization of water from the skin are so well known that a passing mention of them is sufficient.

The temperature of the skin in any small area is the resultant of the heat brought to it largely by the blood and of the heat lost by the various dissipative processes which have been mentioned. Hence the amount of heat to be lost, in order to maintain constancy of the internal temperature of the body, and the temperature and humidity of the environment into which this energy has to be dissipated are the two chief factors which control the temperatures of various parts of the surface of the body. Recent investigations[2, 3] have indicated that, under increased environmental temperatures or with an increased production of heat, there is a change in the amount of blood, under the control of the mechanisms regulating temperature, which is brought to various portions of the surface of the body. Apparently, within the comfortable ranges of temperatures and humidities, this accuracy of regulation, in order that the production of heat may equal the loss of heat, is accomplished largely by the peripheral vascular systems of the extremities.

This presentation gives the results of investigations concerning the changes in temperature of the skin in various regions of the body produced under varied but controlled environmental conditions, direct evidence concerning the portions of the surface of the body which are chiefly concerned with the exchanges of energy between the body and its environment, as well as furnishing indirect evidence concerning the increase or decrease of supply of blood to various peripheral regions.

Controlled Environmental Temperatures and Humidities

In these investigations three psychrometric rooms were used, equipped with apparatus capable of maintaining the environmental temperatures within ±1 F and the humidity within ±3 per cent. In general, these rooms have been maintained at 65 to 68 F (17.5 to 20 C), 76 to 78 F (24.4 to 25.5 C) and 90 to 92 F (32.2 to 33.3 C) respectively with a relative humidity of 40 per cent in order to investigate the effects produced by sudden changes in environmental temperature (accomplished by moving the bed and subject from one room to another) on the skin temperatures of various regions of the body in a basal metabolic condition as well as subsequent to the ingestion of food, exercise or change of posture of the body or of the extremities only. The maintenance of a room at a temperature of 77 F (25 C) and 40 per cent humidity the year around provides a means of investigating, under standard conditions, the skin temperatures of normal subjects and of those who have peripheral vascular deficiencies. Environments which are relatively warm (90 F) and cool (65 F) respectively enable these and other types of data to be obtained in cases of persons who complain of symptoms and reactions produced by heat and cold.

The subjects wore very light weight pajamas, so arranged that the arms and legs were exposed, and remained in a horizontal position on a comfortable bed during the period from 9 a. m. to 5 p. m. The head was raised slightly and a stand was arranged to carry reading material in order to minimize restlessness and to insure the arms remaining as much as possible in the horizontal position.

Thermocouples and the Measurement of Skin Temperatures

The temperatures of the plantar surfaces of the right and left great toes (designated in Fig. 1 by the numer-

[1] A Method for the Determination of Heat Production Over Long Periods of Time, L. H. Newburgh, F. H. Wiley and F. H. Lashmet, *Jour. Clin. Investigation*, 1931, *10*:703.

[2] The Rôle of the Extremities in the Dissipation of Heat, W. G. Maddock and F. A. Coller, *Am. Jour. Physiol.* 1933, *106*:589.

[3] The Function of Peripheral Vasoconstriction, F. A. Coller and W. G. Maddock, *Ann. Surg.*, 1934, *100*:983.

*Director, Division of Physics and Biophysical Research, The Mayo Foundation and The Mayo Clinic.

**Associate, Division of Physics and Biophysical Research, The Mayo Foundation and The Mayo Clinic.

Presented at the 43rd Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, St. Louis, Mo., January, 1937.

als 2 and 3), the volar sides of the distal phalanges of the right and left middle fingers (7 and 8), upper legs (4 and 5), ulnar wrists (9 and 10) and forehead (6) were measured by means of copper-constantan thermocouples. Thermocouple No. 1 was used for checking the temperature of the room in the vicinity of the subject or, in many instances, was a thermocouple so constructed and encased as to be suitable for the measurement of the rectal temperature. Details relative to the construction of thermocouples and germane topics are to be found in a previous paper.[4] Each thermocouple was fastened in position by narrow strips of adhesive tape, the thermocouple leads (each 10 ft in length) being arranged and gathered into two suitable holders at the head and foot of the bed to assist in preventing looseness or poor contacts of the thermocouples. The distal ends of the copper and constantan conductors are fastened to strips of copper and constantan which, in turn, are rigidly fastened into blocks of bakelite. These terminals are then plugged into a series of constantan-copper receptacles. By connecting the constantan receptacles in series with the constantan element of the common junction maintained at a specified temperature (42 C) and by using a bank of copper switches, it is possible to introduce any desired thermocouple into the galvanometric circuit. The deflections of the galvanometer, converted into equivalent degrees Centigrade, enable the investigator to obtain the skin temperatures very rapidly and with an accuracy of about 0.2 C. Similar sets of receptacles (20 in a room) are installed in each room and the readings of skin temperature are made by the operator at the central switchboard. Such an ensemble makes it possible to transfer bed, patient and thermocouples from one room to another, hence deleting the errors and delays occasioned by removing and replacing thermocouples. Data on several subjects can be obtained during the working period.

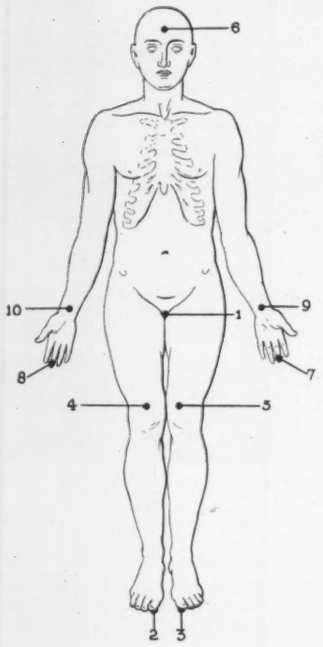


Fig. 1—Diagrammatic sketch showing the location of thermocouples

Skin Temperatures and the Basal Metabolic State

When the expression *basal metabolic state* is used, certain conditions are requisite namely, fasting, normal body temperature, muscular relaxation and comfortable environment. The fasting, resting nude subject in an environmental temperature of about 75 to 77 F (24 to 25 C) with a relative humidity of 20 to 40 per cent produces heat at the basal rate. Since the internal temperature of the body remains constant it follows that the removal of heat from the body must be at the rate at which it is produced. It is necessary, therefore, to obtain data concerning the values of the skin temperatures in various areas of the body in the basal state in order properly to evaluate the rôle which the various portions of the surface of the body play in the dissipation of heat so that the temperature of the body, as evidenced by rectal readings, may be kept constant. Previous investigations[5], [6], [7] have shown that, in an environment of approximately 25 C and relative humidity of 25 per cent, the skin temperatures of the forehead, trunk and extreme upper portions of the arms and legs are commensurate and generally within the range of 32 to 35 C, whereas there is a temperature gradient in the extremities, the lowest temperatures being found in the fingers and toes.

A set of representative data obtained on a subject in the basal state is shown in Fig. 2. The room temperature was maintained at 77 F (25 C) with a relative humidity 40 per cent. Readings of the temperatures of the plantar surface of the left great toe only (curve 4) are given. Readings obtained under the same environmental conditions on the right great toe and other toes of this and other normal subjects have shown that the temperature curves closely parallel each other with temperature differences ranging between 1 and 2 C. The time-temperature curve of the ulnar wrist follows quite closely the curve for the finger, and is about 1 C lower at the corresponding time of measurement. The temperatures of the toes are maintained at a quite constant

[4]The Electromotive Thermometer: An Instrument and a Method for Measuring Intramural Intravenous, Superficial and Cavity Temperatures. Charles Sheard, *Am. Jour. Clin. Path.*, 1931, *1*:209.

[5]Loc. Cit. Notes 2 and 3.

[6]Human Calorimetry. III. Temperature Distribution, Blood Flow and Heat Storage in the Body in Basal Condition and After the Ingestion of Food, A. C. Burton and J. R. Murlin, *Jour. Nutrition*, 1935, *9*:281.

[7]Changes in Surface and Rectal Temperatures in Man Produced by the Ingestion of Food Subsequent to Twenty-four Hour Fast, J. F. Herrick and Charles Sheard, *Am. Jour. Physiol.*, 1935, *113*:62.

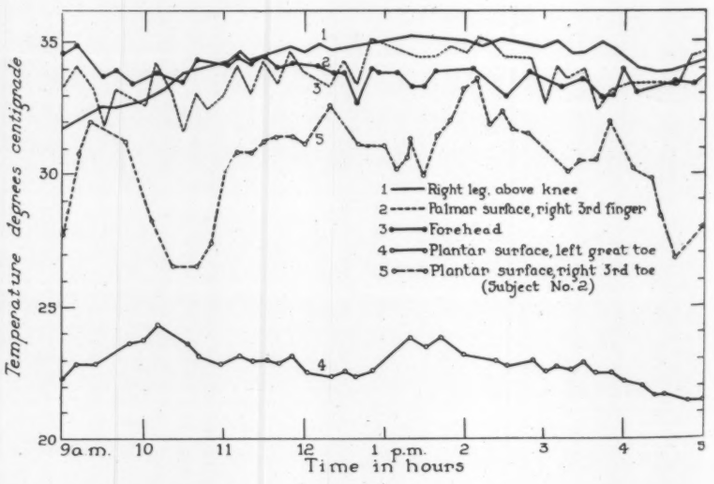


Fig. 2—Curves (1, 2, 3 and 4) of the skin temperatures of a normal male. Curve 5 shows the temperatures of the toes of another male of the same age, height and (approximately) weight. Both subjects in the same basal metabolic state, environmental temperature 77 F (25 C) and relative humidity 40 per cent

level, whereas the finer adjustments, or regulations of heat loss from the body, are controlled largely by the fingers and lower portions of the arms, as is evidenced by the rhythmically fluctuating curve of the temperatures of the fingers.

Curve 5 (Fig. 2) is the plot of the temperature readings of the toe of another subject occupying the room at the same time, and is introduced to show the differences in the temperatures of the extremities which may arise in individuals having nearly equal basal metabolic rates. The temperature of the forehead of subject No. 2 was maintained at 34.5, ±0.25 C. The time-temperature data on the fingers and wrists show slight variations from 35.5 C. The temperatures of the forehead, fingers, wrists, and upper portions of the legs maintained maximal and approximately constant values; the dissipation of heat under the environmental condition specified was largely controlled in this person by the toes, feet and lower portions of the legs.

The initial portion of curve 5 shows a set of time-temperature relations for the toes which we have frequently encountered in these investigations when the subject has been up and around for an hour or more before undressing and lying down on the bed. There is a rapid rise in temperature for the first half hour, followed by a corresponding decrease in the succeeding half hour, to be followed in turn by a rise to a value which is fairly high. These initial effects are evidently associated with change in posture and are the subject of a separate investigation.

It should be pointed out that the basal rates of these subjects were: No. 1, 43.7 cal per square meter per hour and No. 2, 41.1 cal per square meter per hour. They were both males, nearly of the same age, height and weight (20 lb difference). The dissipation of heat, as indicated by the measurements of the skin temperature, is considerably greater in the individual who has the lower basal metabolic rate. Attempts[8] have been made to correlate the average skin temperatures of the great toes with the basal metabolic rates under constant environmental temperatures. The results obtained in these investigations cause doubt of the existence of such a linear relationship.

These tests definitely point to the necessity for obtaining the various skin temperatures over a considerable period of time while the subject is in the basal state, before proceeding to measurements of the effects produced by changes in environmental conditions, the ingestion of food, exercise, posture and the like or, again, in clinical investigations of individuals having vascular diseases.

Thermal Changes Induced by the Ingestion of Food

The necessity of basal metabolic conditions is emphasized when investigations are to be made on the so-called specific dynamic action of foods, or in the determination of the thermal changes produced in various areas of the skin of the body subsequent to the ingestion of food. After a fast of from 12 to 18 hours and after the temperatures in each area have remained constant to within approximately 1 C, the subject ate a meal which was balanced in essential types of food and sufficient to satisfy the hunger. In all instances, the temperature of the forehead remained constant within 1 to 1.5 C throughout the day. In general, shortly after the ingestion of food, the temperatures of the fingers, wrist and upper leg rise to their maximal values. The

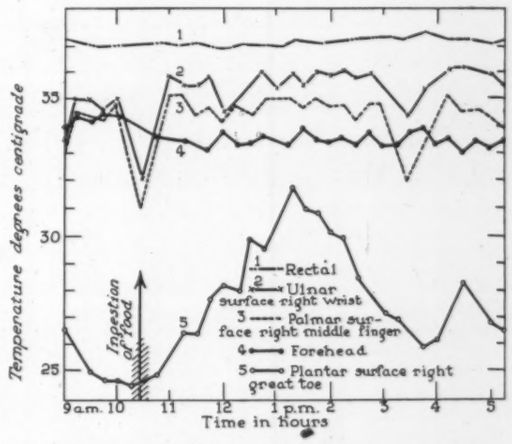


Fig. 3—Curves showing the time-temperature relationships of the wrists, fingers and toes of a normal male subject in the basal condition and after the ingestion of food. Environmental temperature 77 F (25 C) and 40 per cent relative humidity

temperatures of the toes and of the lower extremities rise, in a room temperature of 25 C and 40 per cent humidity, in a manner represented in curve 5 of Fig. 3. The time of the initial temperature change, the maximal value attained and the duration of the cycle of the change of the temperatures of the extremities vary with different individuals and in the same individual on different days. In general, it may be stated that the temperatures of the fingers and lower portions of the arms rise to their maximal values before the regulation of the elimination of heat is taken up by the lower extremities. There may be more than one cycle in the rise and fall of temperatures of the toes after the ingestion of food. In general, the blood pressures increased 5 to 15 per cent and the pulse rates were augmented 10 to 20 per cent shortly after the subject had eaten. These changes varied in their periods of duration, but, in general, decreased to normal values within an hour or two.

These results confirm the general trend of the conclusions recently reached in other investigations.[9] There are minor changes in rectal temperature following the ingestion of food. The changes in surface temperatures of the body, particularly in the extremities, subsequent to the ingestion of food are indicative of increase in blood flow or increased rate of circulation. These investigations concerning the superficial thermal changes in man find their counterpart and physiological explanation in previous work[10] concerning the effects of digestion on the blood flow in dogs.

[8] Loc. Cit. Note 2 and 3.

[9] Loc. Cit. Notes 6 and 7.

[10] The Effect of Digestion on the Blood Flow in Certain Blood Vessels of the Dog, J. F. Herrick, H. E. Essex, F. C. Mann, and E. J. Baldes, *Am. Jour. Physiol.*, 1934, *108*:621.

Effects on Skin Temperature

Changes of Environmental Temperature

After obtaining the findings on the changes in superficial temperatures produced in a group of normal individuals in the basal state and after the ingestion of food, investigations were made concerning the effects of changes of environmental temperature, the humidity remaining at 40 per cent, on the sites and manner of control of the loss of heat or its prevention as the case might be. Fairly characteristic results are diagrammed in Figs. 4 and 5.

The records of the measurements of skin temperature given in Fig. 4 clearly show the rôle played by the extremities, particularly marked in the fingers and toes, in the regulation of the loss of heat from the body, in the basal state, in order that the internal temperature of the body may be maintained quite constant at 98.6 F (37 C). The subject entered the room at 64 F (18 C) from an environmental temperature of approximately 78 F. At the end of an hour's time the temperature of the toes reached the temperature of the room. The marked regulation of loss of heat was accomplished by the fingers and lower portions of the arms, the temperatures of the fingers dropping from 34 to 22 C. The course of the changes of temperature of the wrist is similar to that of the fingers but not as great in range. On rapidly changing the room temperature to 68 F (20 C) the temperatures of the toes rose 1.5 C but were slightly below the room temperature at the end of 1.5 hours. There was a sudden rise in the temperatures of the fingers, followed by a lowering of the temperatures to a steady state approximating 25 C. The temperature of the wrist was fairly steady. When the environmental temperature was raised to 72.5 F (22.5 C), the temperatures of the fingers rose rapidly and were maintained in the range of 32 to 34 C, the wrist being at a temperature of 34 to 35 C. The temperatures of the toes rose in about an hour to a constantly maintained value of about 21.5 C. These results show that the toes assume the room temperature throughout the range of environmental temperatures (64 to 72.5 F), and that the loss of heat from the body is largely regulated by the hands and lower portions of the arms. On repeated occasions this subject, in the basal state, showed temperatures of the great toes ranging from 31 to 33 C in an environment of 77 F (25 C), the humidity remaining 40 per cent. It seems possible, therefore, to establish quite definitely the conditions of environmental temperature at which the lower extremities begin to function actively as the regulators of the dissipation of heat from the body.

The ingestion of a standard meal showed the marked rise in temperatures of the toes from about room temperature (22 C) to 30 C.

The curves of Fig. 5 give the time-temperature relationships for the forehead, wrist, finger, leg and toe of another subject who, after fasting 15 hours, was placed in the room at 77 F (25 C) and, after 2.5 hours, was removed into an environmental temperature of 68 F (20 C). About 2.5 hours later (total fast of 18 hours) the subject ate a meal; the data on superficial temperatures are plotted in the right-hand portion of Fig. 5. After the ingestion of food, the temperatures of the toes continued to fall and finally reached room temperature. The increased flow of blood to the fingers and wrists caused the marked rises in temperatures indicated, from which it may be concluded that, under the environmental conditions specified, the maintenance of the internal temperature of the body was largely accomplished by

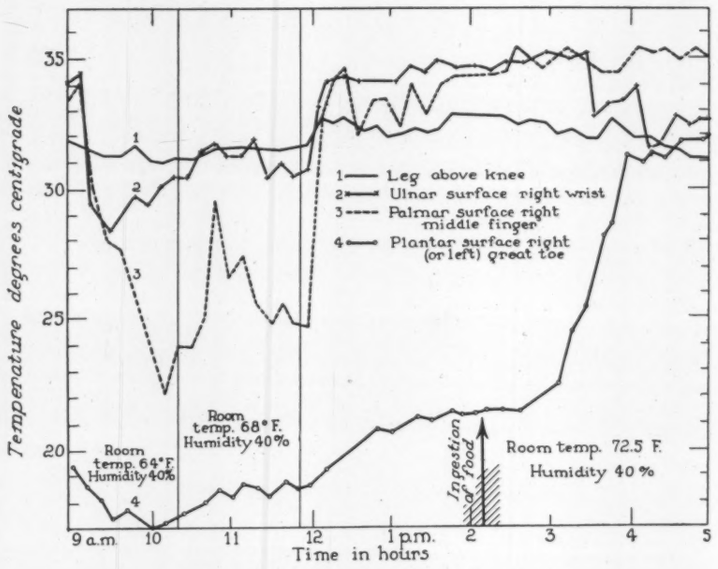

Temperature degrees centigrade
35
30
25
20
1 — Leg above knee
2 — Ulnar surface right wrist
3 ---- Palmar surface right middle finger
4 — Plantar surface right (or left) great toe
Room temp. 64°F. Humidity 40%
Room temp. 68°F. Humidity 40%
Ingestion of food
Room temp. 72.5 F. Humidity 40 %
9 a.m. 10 11 12 1 p.m. 2 3 4 5
Time in hours

Fig. 4—Changes in the superficial temperatures of the legs, wrists, fingers and toes of a normal male in the basal state produced by changes in environmental temperature, the humidity being maintained at 40 per cent

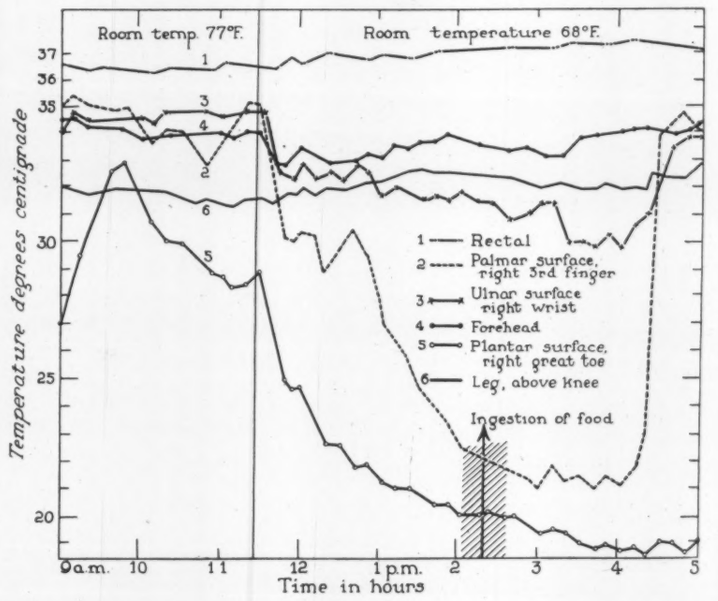


Fig. 5—Changes in the skin temperatures of the legs, wrists, fingers, toes and forehead of a normal male, in the basal state, produced by changes of environmental temperature, and after ingestion of food. Relative humidity, 40 per cent

the loss of heat from the hands and forearms. In general, these and similar data demonstrate the important rôle which the extremities play in the regulation of the dissipation of heat from the body under environmental temperatures ranging from 65 to 85 F.

Changes of Environmental Humidity

The effects of changes of humidity were investigated, the temperature of the room remaining constant, on the temperatures of various areas of the skin in a few individuals in an environmental temperature of 77 F, ±1 F (24.8 to 25.5 C). Therefore, this portion of the discussion in particular should be considered in the nature of a preliminary account. A fairly typical set of time-temperature relationships concerning the thermal findings on the finger, ball of the great toe and the plantar surface of the great toe are given in the curves of Fig. 6. The subject, in the basal state, was placed in the room maintained at 70 to 75 per cent humidity. The temperature of the great toe remained at 25.3 ±0.5 C for a period of 3 hours, the fingers and the wrists (not shown in Fig. 6) showing frequent cyclic changes in the range 31.5 to 34 C. The humidistat was then set for 30 per cent and the humidity dropped to the indicated value in about half an hour (at the fourth hour on the time scale). After remaining in the environmental humidity of 30 per cent for two hours, the humidistat was set at 75 per cent (at the sixth hour) and reached that value in half an hour. It is quite obvious from the data that the temperatures of the toes are several degrees (ranging from 2 to 4 C) lower in an environmental atmosphere of 30 per cent relative humidity. Also, the regulation of loss of heat by the fingers and wrists is more pronounced in low humidities. That the results are due essentially to changes in humidity is evidenced by the fact that the temperatures of the toes were elevated several degrees when the humidity was again increased to 75 per cent. Furthermore, data on the same subject, in a basal state, obtained on the preceding day under environmental conditions of 25 C and 40 to 45 per cent humidity, demonstrated that the temperatures of the great toes were 24.5 ±0.7 C. The value 24.5 C fits in between the temperatures of the toes at 30 and 75 per cent humidity respectively.

It is probable that the increase of humidity causes increased temperatures of the feet and toes by reason of the fact that the normal loss (about 25 per cent) of heat by vaporization of water from the skin and lungs is markedly reduced.

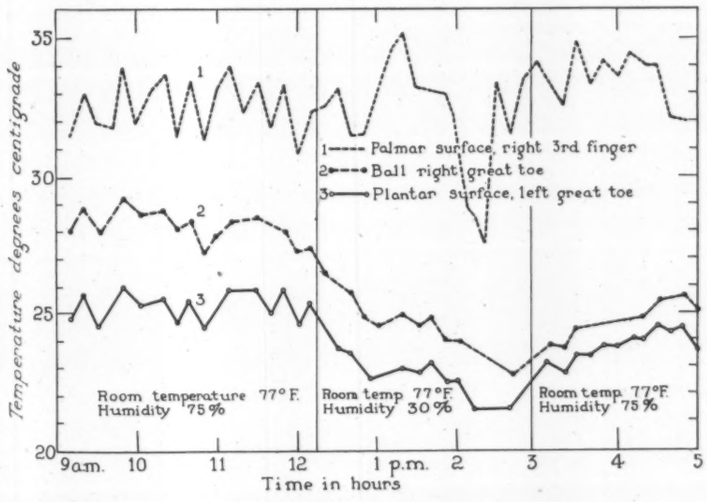


Fig. 6—Curves showing the relationships between the changes in skin temperatures of the extremities and changes in humidity, the temperature of the room being maintained at 77 F. Normal male in the basal condition

Skin Temperatures in Vascular Deficiencies

In the preceding paragraphs, data obtained under specified and controlled environmental conditions on young healthy male subjects have been presented to show the important part played by the extremities in the control of dissipation of heat from the body. Increase or decrease of superficial temperatures is indicative of a corresponding change in the supply of blood to the peripheral tissues. In turn, the changes in the supply of blood are controlled largely by vasoconstriction of the blood vessels. Hence it follows that the marked regulation of the dissipation of heat by the extremities is accomplished by an equally marked and varying degree of peripheral vasoconstriction.

A discussion of the function of vasoconstriction and an application of the data and facts acquired by measurements of skin temperatures or other experimental procedures to conditions of peripheral vascular deficiencies are not within the scope of this paper. However, in order to contrast the type of data obtained by measurements of skin temperatures in vascular disease with the results obtained, under identical environmental conditions, from normal individuals, the time-temperature curves of Fig. 7 are included. These data should be compared with the findings shown in Fig. 3. The basal metabolic rates were practically the same in the two individuals. In both instances, the ranges and the courses of the time-temperature changes of the fingers, wrists and forehead were practically the same.

Under basal conditions, and in an environmental temperature of 77 F (25 C) and relative humidity of 40 per cent, Fig. 7 shows that the average temperature of the plantar surface of the right great toe was about 27.5 C, while the average reading on the left great toe was 30.5 C. These findings indicate differences in the heat-regulating functions of the two lower extremities due to varying degrees of vasoconstriction or supply of blood. Following the ingestion of food there was a small increase (2 C) in the temperatures of the toes of both feet, thus definitely indicating the inability of the lower extremities to function as the regulators of the dissipation of heat from the body in the manner evidenced by normal persons under like conditions of environment and basal metabolism as indicated in Fig. 3.

The results of this series of investigations in general, as well as the findings of other investigators, show that, under certain environmental conditions, a portion of the so-called vasospasm is simply normal vasoconstriction, hence differentiation can be made only by studies of

the peripheral vasoconstriction (as indicated by measurements of the skin temperatures of the extremities) in relation to the environmental conditions and by comparison with normal subjects under the same conditions.

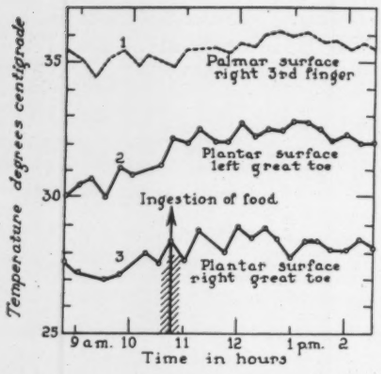


Fig. 7—Curves showing the time-temperature relationships for the fingers (either hand), right and left great toes in a case of peripheral vascular disease

Summary

In this report there is presented evidence concerning:

1. The rôle of the extremities in the dissipation of heat from the body in order that the loss of heat may equal the production of heat, thereby maintaining the internal temperature of the body constant.

2. The influence of changes of environmental conditions on the temperatures of the skin in various areas in normal individuals in the basal condition.

3. The effects of the ingestion of food and the subsequent regulation of the dissipation of the increased production of heat by the upper and lower extremities of the body under varied but controlled environmental conditions.

4. The relative functions of the upper and lower extremities respectively in the control of the loss of heat from the body, under various controlled environments, in the basal state and following the ingestion of food.

5. The significance of the deductions, drawn from these investigations, concerning the function of vasoconstriction and the application of the experimental procedures which have been presented to the study of normal vasoconstriction and peripheral vascular deficiencies.

Exhaust System Standards Drafted

The *American Standards Association* has just released a report on fundamentals relating to the design and operation of exhaust systems which has a direct bearing upon the problem of occupational disease prevention. This report was presented at the recent National Conference on Silicosis in Washington, D. C., by the Engineering Committee of the Conference.

While the occupational disease problem is partly a medical one, the matter of minimizing exposure to poisonous dusts, gases, and fumes is purely an engineering problem and includes the important problem of installing exhaust equipment that will carry off the toxic dusts and gases present in certain industrial processes such as rock drilling and spray painting. Different types of dusts and gases require different treatment. Yet there are certain fundamental engineering principles common to the control of all.

It is these basic engineering principles that the committee deals with in its present report. Today many state regulations demand that employers provide *adequate* ventilation. But what is *adequate?* Some laws and codes require a definite amount of static suction as an index of exhaust system efficiency, but there are other engineering principles involved. What are the minimum air velocities required to *capture* the dust arising from certain grinding wheel processes or the fumes from electroplating? To what extent is air-cleaning practical to prevent recontamination of plant air from the outside, or to permit recirculation of air discharged from the exhaust system in the plant? What pressure losses can an engineer expect from the various types of elbows and branches common to exhaust piping? The report goes deeply into the question of plant layout, exhaust hood design, air velocities, methods of measuring static suction, etc. It also considers the matter of exhaust system piping and of maintenance.

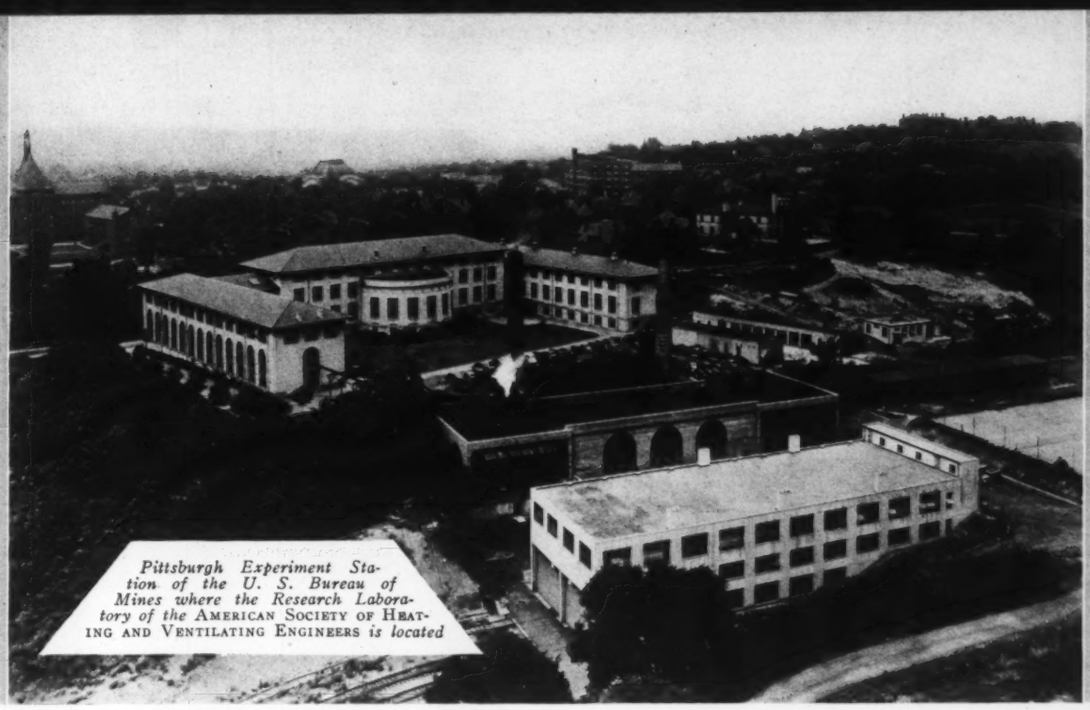
The report is intended as a guide to those desiring to install and use exhaust systems as well as to the manufacturer and designer of such systems. The committee that developed this report does not consider it in any way final but hopes that through its critical analysis a body of technical experience may be built up on which to base future action in the elimination of industry's worst occupational disease hazard—toxic dusts and gases.

This is the first step in developing a set of separate standard specifications for exhaust hood designs and air velocities for each distinct process or industry in which the occupational disease hazard is present. In all this work a national committee of eminent toxicologists and pathologists headed by Dr. R. R. Sayers, Senior Surgeon of the U. S. Public Health Service, is acting in an advisory capacity to set threshold limits beyond which the presence of certain dusts and gases becomes a menace to workers.

The *ASA* committee on Exhaust Systems which released this report includes representatives of the following organizations, working under the administrative leadership of the *International Association of Industrial Accident Boards and Commissions:*

American Foundrymen's Association
American Public Health Association
American Society of Heating and Ventilating Engineers
American Society of Mechanical Engineers
Association of Manufacturers of Wood Working Machinery
Foundry Equipment Manufacturers Association
Grinding Wheel Manufacturers Association
International Association of Governmental Labor Officials
Manufacturing Chemists' Association of the U. S.
National Association of Fan Manufacturers
National Association of Mutual Casualty Companies
National Bureau of Casualty & Surety Underwriters
National Electrical Manufacturers Association
National Founders Association
National Safety Council
National Spray Painting & Finishing Association
U. S. Department of Agriculture, Bur. of Chemistry & Soils
U. S. Department of the Interior, Bureau of Mines
U. S. Department of Labor
U. S. Department of Labor, Bur. of Labor Statistics
U. S. Navy Department, Bur. of Construction & Repair
U. S. Treasury Department, Bur. of Public Health Service

Theodore Hatch, Division of Industrial Hygiene, New York State Department of Labor, is chairman of the subcommittee which drafted the report.



Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS *is located*

COMMITTEE ON RESEARCH

W. A. DANIELSON, *Chairman;* W. L. FLEISHER, *Vice-Chairman;* F. C. HOUGHTEN, *Director;* DR. A. C. WILLARD, *Technical Adviser;* O. P. HOOD, *Ex-Officio Member. One Year:* C. A. DUNHAM, W. L. FLEISHER, ELLIOTT HARRINGTON, A. P. KRATZ, H. C. MURPHY. *Two Years:* W. A. DANIELSON, C. E. LEWIS, D. W. NELSON, C. TASKER, C.-E. A. WINSLOW. *Three Years:* H. E. ADAMS, A. E. STACEY, G. L. TUVE, J. H. VAN ALSBURG, J. H. WALKER.

Executive Committee: W. A. Danielson, *Chairman;* W. L. Fleisher, J. H. Walker.

Technical Advisory Committees

Committee on Air Cleaning—IP-4: H. C. Murphy,* *Chairman;* M. I. Dorfan, C. E. Lewis,* S. R. Lewis, G. W. Penney, A. L. Simison, W. O. Vedder.

Committee on Air Conditioning Requirements of Glass—IF-18: M. L. Carr, *Chairman;* F. L. Bishop, A. N. Finn, E. H. Hobbie, R. J. Lillibridge, R. A. Miller, F. W. Parkinson, W. C. Randall, J. T. Staples, C. Tasker,* G. B. Watkins.

Committee on Air Distribution—IP-21: Ernest Szekely, *Chairman;* S. H. Downs, M. K. Fahnestock, F. J. Kurth, D. W. Nelson,* C. H. Randolph, J. E. Schoen, G. L. Tuve,* J. H. Van Alsburg.*

Committee on Air Friction—IP-6: J. H. Van Alsburg,* *Chairman;* C. A. Booth, S. H. Downs, R. D. Madison, L. B. Miller, L. E. Smith, C. M. Humphreys.

Committee on Atmospheric Impurities and Resulting Safety and Health Requirements—IP-26: Theodore Hatch, *Chairman;* J. J. Bloomfield, C. A. Booth, Philip Drinker, Dr. Leonard Greenburg, Elliott Harrington,* H. B. Meller.

Committee on Climate and Air Conditioning—C-24: Dr. C. A. Mills, *Chairman;* Major G. C. Dunham, James Govan, Dr. W. J. McConnell, C. F. Neergaard, Dr. F. M. Pottenger, Jr., E. L. Weber, Prof. C.-E. A. Winslow.*

Committee on Comfort Air Conditioning—OH-22: C. Tasker,* *Chairman;* A. E. Beals, F. R. Bichowsky, Thomas Chester, F. E. Giesecke, Elliott Harrington,* Dr. E. V. Hill, R. E. Keyes, C. P. Yaglou.

Committee on Corrosion in Air Conditioning Equipment—IF-14: A. E. Stacey, Jr.,* *Chairman;* A. F. L. Anderson, M. L. Diver, F. L. LaQue, C. E. Lewis,* R. M. Palmer, F. N. Speller, C. M. Sterne, R. T. Thornton, J. H. Young.

Committee on Corrosion in Steam Systems—IF-2: J. H. Walker,* *Chairman;* E. L. Chappell, W. H. Driscoll, C. A. Dunham,* L. B. Miller, R. R. Seeber, C. M. Sterne.

Committee on General Air Conditioning Comfort Requirements—OH-5: C. P. Yaglou, *Chairman;* J. J. Aeberly, R. R. Sayers, C.-E. A. Winslow.*

Committee on Heat Requirements of Buildings—IF-8: O. W Armspach, *Chairman;* P. D. Close, W. H. Driscoll, H. M. Hart, P. E. Holcombe, V. W. Hunter, H. H. Mather, E. C. Rack, F. B. Rowley, R. J. J. Tennant, J. H. Walker.*

Committee on Heat Transfer of Finned Tubes with Forced Air Circulation—IP-10: F. B. Rowley, *Chairman;* H. F. Hutzel, C. E. Lewis,* E. J. Lindseth, R. H. Norris, W. E. Stark, G. L. Tuve.*

Committee on Insulation—IF-23: L. A. Harding, *Chairman;* E. A. Allcut, J. D. Edwards, E. C. Lloyd, R. T. Miller, E. R. Queer, T. S. Rogers, F. B. Rowley, W. S. Steele, C. Tasker,* B. Townshend, G. B. Wilkes.

Committee on Intermittent Heating—IP-20: E. K. Campbell, *Chairman;* W. L. Cassell, Prof. E. F. Dawson, N. W. Downes, F. E. Giesecke, J. M. Robertson, J. H. Kitchen, Prof. A. H. Sluss, G. L. Tuve.*

Committee on Psychrometry—C-11: F. R. Bichowsky, *Chairman;* C. A. Bulkeley, J. A. Goff, Dr. E. V. Hill, F. G. Keyes, A. P. Kratz,* W. M. Sawdon.

Committee on Radiation with Gravity Air Circulation—IP-9: M. K. Fahnestock, *Chairman;* H. F. Hutzel, J. P. Magos, J. W. McElgin, J. F. McIntire, D. W. Nelson,* R. N. Trane, T. A. Novotney.

Committee on Relation of Body Changes to Air Changes—OH-3: Dr. E. V. Hill, *Chairman;* N. D. Adams, J. J. Aeberly, John Howatt, A. P. Kratz,* P. J. Marschall, V. L. Sherman.

Committee on Sound Control—IF-1: J. S. Parkinson, *Chairman;* C. M. Ashley, V. O. Knudsen, R. F. Norris, C. H. Randolph, J. P. Reis, A. E. Stacey,* F. R. Watson.

Committee on Summer Air Conditioning for Residences—IP-7: M. K. Fahnestock, *Chairman;* E. A. Brandt, John Everetts, Jr., Elliott Harrington,* H. F. Hutzel, E. D. Milener, K. W. Miller, E. B. Newill, F. G. Sedgwick, J. H. Walker.*

Committee on Treatment of Air with Electricity—C-17: Prof. C.-E. A. Winslow,* *Chairman;* Prof. Vannevar Bush, W. H. Carrier, L. W. Chubb, Major W. D. Fleming, R. F. James, L. R. Koller, Dr. C. A. Mills, Prof. E. B. Phelps, Prof. G. R. Wait, Prof. W. T. Wells.

*Member of Committee on Research.

A. S. H. V. E. Research Goes Into Action

A News Report of Progress at the St. Louis Meeting

By Brewster S. Beach*

FROM marking time to marching forward, Research swung into action along all fronts at the 43rd Annual Meeting of A.S.H.V.E. at St. Louis.

Signalizing the end of a period of reduced activity caused by the economic depression, new programs and policies were outlined aimed at the solution of the many pressing technical problems that confront the heating, ventilating and air conditioning profession.

While predicting the extension of air conditioning into such new fields as the treatment of disease, in which astute observers see future possibilities of significant importance, the strengthening and extension of knowledge to improve the practical application of heating, ventilation and air conditioning received a large share of attention from the 15 members of the Committee on Research and the twenty-one technical advisory committees assisting it.

Particular attention was directed to problems affecting the use of building materials under new conditions resulting from the growing popularity of air conditioning in residences and other buildings. Of special news interest at the St. Louis meeting was the decision of the Technical Advisory Committee on Air Conditioning Requirements for Glass to begin immediate fundamental investigations of glass building blocks in anticipation of developing scientific data covering heat loss, infiltration, effect of solar radiation and application standards for this rapidly growing form of building construction.

Glass Research of Special Interest

Included in the broad investigation will be the entire subject of the use of glass, including various types of window construction, double sash and the effect of shading appurtenances in the form of awnings, screens, blinds and like devices. Recognizing the immediate importance of prompt and united action to develop a firm scientific foundation for this important subject, the committee authorized the solicitation of special funds for the employment of a research assistant in the Society's Laboratory to gather, study and correlate existing data, devise testing methods, conduct field experiments and set up standards for the guidance of the glass and window industries.

Closely related to these new studies of glass, and of even more basic importance perhaps, was the continuing work directed to the solution of new problems arising in the building insulation field. This subject was attacked by the Committee on Research through the Technical Advisory Committee on Insulation. Keenly aware of the necessity of a thorough overhauling of all existing data, the committee finds itself faced with the necessity of building a foundation of technical knowledge which will meet conditions arising out of the use of many new forms of insulation materials and the problems that confront the building industries when utilizing these materials.

The committee set up no less than 21 points to be considered and investigated in what amounts to a complete revamping of the basic data on insulation, most of which center on the reaction of insulation materials subjected to humidified air from within a building. Linked with this investigation the insulation committee feels the need of devising better testing methods for measuring the efficiency of insulation together with the establishment of standards in its application.

Inasmuch as the air conditioning and building industries are so closely related, this basic study of insulation fundamentals and insulation practice touches upon the interests of almost every phase of the heating, ventilating and air conditioning arts. The magnitude of the task confronting it lead the committee during the St. Louis meeting to consider raising special funds with which to finance intensive research along the lines mapped out for its 1937 program.

*Director, Information Service, Committee on Research.

RESEARCH FUNDS NEEDED

The heating, ventilating and air conditioning industries are entering a period of intensive development which will require, as perhaps never before, a sound and firm foundation of engineering facts and data upon which to build for future expansion. This basic information can be developed by the Society.

A contribution now to the Research Fund of the American Society of Heating and Ventilating Engineers is an investment which will insure a program aimed to keep these industries abreast of the scientific progress that is so vital to expansion.

The research work of the Society is devoted to the single minded purpose of strengthening the base upon which these industries rest. To more effectively perform its job as the source of unbiased technical information, it requires a substantial fund, over and above that now supplied through the Society membership, to carry on a broad program for the next two years.

Contributions or pledges should be sent to the A. S. H. V. E. Committee on Research, 51 Madison Ave., New York.

A. E. Stacey

H. E. Adams

J. H. Walker

G. L. Tuve

J. H. Van Alsburg

Vying both in importance and interest with questions of applied research to solve definite problems, the St. Louis meeting brought into sharp relief the progress that has been made in opening up new avenues for the application of air conditioning in the field of human comfort. Ranging from studies of the proper requirements for summer cooling to the effect of climate on air conditioning fundamentals, this broad division of the Research Committee's work includes the application of air conditioning to the treatment of disease and even looks ahead to the time when man has so far learned nature's secret as to be able to capture and imprison in indoor air, the vital ingredient of outdoor air that gives it that zestful tang.

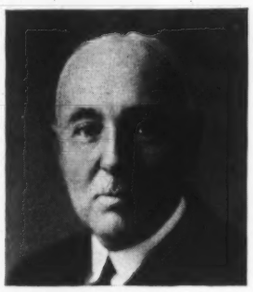
Between these extremes the 1937 program for research, as outlined last month, includes fundamental work dealing with ventilation requirements for the elimination or minimizing of odors and smoke, determination of the factors contributing to the causation of drafts and further studies of the science of air distribution in all forms, only a few of which are mentioned here.

There can be little question that the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, judging by work performed by its Committee on Research in the course of the last annual meeting, has embarked upon a program which is of vital interest and practical value to every member of the Society, deserving, as never before, of the whole hearted support of all who call heating, ventilating and air conditioning their business.

When it is realized that more than 90 per cent of its activity is on a voluntary basis and that the stability and progress of the whole industry rest upon its efforts, the Committee's campaign to raise funds to meet the ever growing demands upon it is not likely to fall upon unresponsive ears.

At the organization meeting of the committee, W. A. Danielson was re-elected chairman. W. L. Fleisher was named vice-chairman. The following new members were elected for three-year terms: A. E. Stacey, vice-president, Buensod-Stacey Air Conditioning, Inc., New York; J. H. Van Alsburg, application engineer, Hart & Cooley Manufacturing Co., Chicago; J. H. Walker, superintendent of Central Heating, Detroit Edison Co., Detroit (re-elected); G. L. Tuve, professor of Heat and Power Engineering, Case School of Applied Science, Cleveland, and H. E. Adams, chief engineer, Nash Engineering Company, South Norwalk, Conn.

New Committee Attacks Problem of Stuffy Air



C.-E. A. Winslow

Encouraging progress in its investigation of the cause of *stuffiness* in indoor air and the search for means of capturing and imprisoning the vital quality which gives outdoor air its zestful tang is reported by the Technical Advisory Committee on the Treatment of Air with Electricity assisting the A.S.H.V.E. Committee on Research in its broad investigation of comfort air conditioning.

Following a meeting held shortly before the 43rd Annual Meeting of the Society in St. Louis, the committee has just released a summary of its discussions outlining an attack on this problem from three fronts (1) Ionization of Air; (2) Ozonation; and (3) Ultra-Violet sterilization of air. Closely linked with these studies is the subject of electric air filtering.

Unusual interest attached to the observations of Dr. G. R. Wait of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, who reported the existence of 200,000,000 ion particles in every exhaled human breath. Professor Wait finds that these particles are positively and negatively charged in approximately equal proportions. He concludes that the presence of these particles in the air of an occupied room may account for the stuffiness attributed to such air, and says:

"If this is the cause of such conditions developing, a remedy should not be difficult to apply. Since the majority of the particles are electrically charged they can be removed by means of an electric filter of the proper dimensions and to which a proper potential is applied." Professor Wait suggested that the development of such means for conditioning air in occupied rooms be undertaken by the committee.

Relating air filtering to the problem of removing the breath particles described by Professor Wait, Dr. L. W. Chubb of the Westinghouse Laboratories told the committee that significant results have followed the development of a method of electrostatic air filtration in a Pittsburgh telephone exchange building. While applied for the purpose of keeping dust from automatic relays and proving superior to any form of mechanical filtration, employees, it was found, could detect by the *feeling* of the air whether the electric or mechanical filtering system was in use. They declared that the electric method gave a distinct feeling of *pep* in the air. Dr. Chubb expressed the belief that this might have resulted from the removal of the breath particles or ions mentioned by Professor Wait.

Air Sanitation Becoming Important

W. T. Wells, of the Harvard School of Public Health, related investigations of ultra-violet sterilization of air, to the problem before the committee, pointing out that such methods would contribute to the whole science of air sanitation, a field which is becoming as important as water and food sanitation.

"Ultra-violet light," Mr. Wells said, "is a very efficient sterilizer and marked success has followed its use in operating rooms where absolute sterilization is so important. Installations in many hospitals are testing the efficiency of various means of interposing ultra-violet light barriers between hospital sections."

Following a discussion of the biological effect of ions by Dr. L. P. Herrington, representing Dr. C.-E. A. Winslow, chairman of the committee, tests concerning which appeared to disclose only negative results, Dr. Robert F. James, Westinghouse Lamp Co., Bloomfield, N. J., described results of the use of ultra-violet light in treating hospital patients, stating that improvement in the operative infection rate was shown and that patients exposed to ultra-violet light experienced very little post operative shock and a shortened period of convalescence.

Dr. Earle B. Phelps, College of Physicians and Surgeons, New York, who presided at the meeting, appointed the following members to draw up reports dealing with their special interests which would then be considered and correlated at another meeting of the committee:

Dr. James: The physiological effects of ozone; Dr. Chubb: The possibility of producing a sterilizing lamp which does not produce ozone. A report of the electric filter, especially with regard to its removal of condensation nuclei or ionized breath particles as described by Dr. Wait; Dr. Wait: The principal facts concerning the general properties of condensation nuclei and large ions; Mr. Wells: Distribution of his reprints on ultra-violet sterilization and amplification of same; Dr. Winslow: A survey of the research on the direct physiological effects of ions; Dr. L. R. Koller, General Electric Research Laboratory, Schenectady: A bibliography of spectral information on ultra-violet light sources: Dr. Phelps: Effect on ventilating techniques and effect of ions on bacteria. Dr. Phelps expressed his belief that the constructive discussions at this first meeting "indicate that we can look forward to a progressive future."

"It is very fortunate," he said, "that so many people who are competent to consider the problems in this field can be brought together in a joint attack upon them."

The Committee on the Treatment of Air with Electricity is one of the newest to be announced by the A.S.H.V.E. Committee on Research.

Proceedings of the 43rd Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

St. Louis, Mo.—January 25-27, 1937

G. L. LARSON, Madison, Wis.
President—1936

WITH an attendance of 503 members, guests and ladies, the 43rd Annual Meeting of the Society was voted an outstanding success and those who journeyed to St. Louis and spent the three days, January 25 to 27, felt well repaid for their time and effort. Every one of the 22 local Chapters was officially represented and every part of the United States and Canada contributed its quota to the attendance. The attendance at technical sessions was exceptional and the discussions were lively and interesting.

The Council held an all-day meeting on Sunday, January 24, and on Monday morning, the Committee on Research and other technical committees were in session.

At 10:00 a. m. on Monday, January 25, President Larson opened a conference of Chapter Delegates and welcomed the representatives of the 22 Chapters.

W. A. Russell, Chairman of the Membership Committee, opened the discussion and told of the mechanics of membership solicitation.

W. H. Driscoll, Past President of the Society, reviewed some of the important happenings in the history of the organization and mentioned some of the pioneers who had rendered outstanding service. He pointed out the value of attending the Annual and Semi-Annual Meetings of the Society and briefly reviewed the history of the first few Chapters. He commented on the relationship between the Society and the Local Chapters and the evidence of sustained interest that members have in the organization as demonstrated by the attendance of 11 past presidents at this meeting.

W. T. Jones, Past President of the Society, spoke on the duties of Chapter Presidents and told of the intangible benefits resulting from contacts made by members at the Society meetings.

D. S. Boyden, First Vice-President of the Society, spoke on the subject of dues payments and the possibility of collecting Chapter dues by the Society. He pointed out some of the advantages and disadvantages and presented two charts showing the number of enrolled Chapter Members, the average cost of operating Chapters and commented on the rate of dues that would be required to carry out a plan of this kind.

In the discussion that followed, comments were offered by E. B. Royer, H. H. Erickson, N. D. Adams, W. H. Driscoll, J. J. Hayes, F. X. Loeffler, T. H. Urdahl, G. E. Olsen, H. M. Hendrickson, James Holt and G. W. F. Myers.

FIRST SESSION—

Monday, January 25, 1937, 2:00 P. M.

The first session of the 43rd Annual Meeting of the Society was called to order by Pres. G. L. Larson, Madison, Wis., at 2:00 p. m. in the Hotel Statler, St. Louis, Mo., on Monday afternoon, January 25. C. R. Davis, president of St. Louis Chapter and chairman of the Committee on Arrangements, welcomed the members to St. Louis and recalled that the Society had met in St. Louis exactly 10 years previously.

On behalf of the Society, President Larson responded and thanked Mr. Davis and the St. Louis Chapter members for their cordial greeting.

President Larson then read the annual report of the president.

Report of the President

It is the usual practice for the President of this Society to come before the members at the time of the Annual Meeting and give them an account of his stewardship during the year just

D. S. Boyden, Boston, Mass.
***President*—1937**

passed. In addition to a report on general activities of the Society he may take advantage of his opportunity and include such general comments as he may feel inclined to give on matters of broader interest pertaining to the future welfare of the organization.

In this brief report, I shall refer only briefly to the status of the major activities of the Society and will confine my remarks more particularly to some of the outstanding problems of the Society as they appear to me. More detailed accounts of Society activities will be brought out in the Report of the Council, the Report of the Secretary, and the Reports of the Research, Guide, Finance, and other Committees.

During my term of office I have visited all but one of our twenty-two Chapters located from coast to coast and in the Dominion of Canada. I have also represented the Society as a speaker at meetings of such organizations as the *Air Conditioning Society of San Francisco,* the *Seattle Engineers Club,* the *Illinois Fuel Merchants Association,* the *Engineers Society of Milwaukee,* and a number of service clubs. The new Texas Chapter is the only Chapter of the Society that your President has not had the pleasure of visiting.

Past experience as chairman of some of our major committees and the fair cross-section of the views of our members obtained on my visits to Chapters has impressed upon me certain ideas that I want to leave with you for any value that they may have.

Before touching upon these ideas let me first make a very brief reference to the condition of the Society in some of its major phases.

Membership. The number of members enrolled at the present time is the largest in the history of the Society. Four hundred and ninety applications were filed during the calendar year of 1936. Due to the number of new members the income from dues was greater than the amount anticipated in the budget for 1936.

The Guide. The Guide 1936 was distributed in greater quantity than any previous edition—14,500 copies to date. The Guide advertising showed an increase of 50 pages over last year. This publication is not only rapidly bringing increased prestige to our Society but it is also becoming one of our major sources of income.

Research. The research division of our organization has passed through some trying experiences in recent years, but I am happy to report that the skies are rapidly clearing and activities are being resumed that had to be dropped through lack of funds. Among other things we are once more getting into position where we can pay our way in connection with co-operative research agreements with the colleges and the current year should see increased activity in this direction.

In closing this report I wish to refer briefly to a number of situations which, for the future welfare of the Society, need serious consideration.

The Guide has become one of the major sources of income for the Society and it should be able to pay its way better than it has in the past. You may be surprised to learn that the members of the Guide Publication Committee have not only devoted many hours of their valuable time in getting out this most valuable piece of work, but in addition they have paid their own expenses to meetings of that Committee.

In view of the income that The Guide brings to the Society the very least we can do is to have the Council vote to defray the expense of the Guide Publication Committee to meetings of that group.

I had the experience of being chairman of the Committee on Research for two years, and I began that career by being elected chairman without having had any previous experience on the Committee. Colonel Danielson has just passed through the same experience this year. Electing to the chairmanship a man who has had no previous experience on the Committee is a decided mistake. It is very unfair to the individual himself and is not conducive to the best interests of the Society. I remember that I spent a large part of my first year as chairman of the Committee on Research trying to find out what it was all about and Colonel Danielson has had a similar experience this past year.

I believe that a ruling should be made that no one can be elected to the chairmanship of the Committee on Research until he has had at least one year's experience on that committee. I think that such a rule would be a good rule for all of our regular committees.

And while I am on the subject of Research I wish to advocate a closer relationship between our research division and our main administrative office in New York, particularly in relation to publicity and the solicitation of funds for research.

Under the present arrangement each new chairman has to appoint his own Research Finance Committee and develop his own publicity campaign. The year is nearly over by the time these are organized and begin to function. Indeed, the Research Chairman is lucky if he can induce someone to undertake the job of chairmanship of the Research Finance Committee. Whoever undertakes it is new at the game and the year is practically over before much has been accomplished. The next year and the next year new groups go through the same inefficient and painful experience. It seems to me that Research Fund Solicitation and Research publicity can be much more efficiently handled by additions to the staff in our New York office, specifically trained for that purpose. The chairman can then be relieved to carry on the main purpose of the job, the development and advancement of research projects.

Respectfully submitted,
G. L. Larson, *President.*

Report of the Treasurer

A. J. Offner, New York, treasurer of the Society, reported that the finances were in excellent condition and called attention to a substantial increase in the General Fund as compared with the previous year. He explained that the detailed report of Society operations

would be given by the chairman of the Finance Committee.

Report of the Finance Committee

J. F. McIntire, Detroit, chairman of the Finance Committee, presented the report of the Society's certified public accountant showing the condition of the finances for the calendar year 1936. He pointed out that income had exceeded budget expectations and that expenditures had been kept within the amount allotted, so that a very satisfactory condition of Society affairs could be presented.

Report of Certified Public Accountant

January 18, 1937.

AMERICAN SOCIETY OF HEATING AND
VENTILATING ENGINEERS,
51 MADISON AVE.,
NEW YORK, N. Y.

Gentlemen:

Pursuant to your request we made an examination of the books of account and records of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—New York, N. Y., and the RESEARCH FUND for the calendar year ended December 31, 1936, and submit herewith our report.

The work covered a verification of the Assets and Liabilities as of the date previously stated and a review of the operating accounts for the year ended December 31, 1936. For this period recorded cash receipts were traced into the depositories; the cancelled bank vouchers were inspected and compared with the cash records and the Dues Income was accounted for.

Submitted herewith is a Balance Sheet showing the financial condition of the Society on December 31, 1936, and your attention is directed to the following comments thereon:

CASH

Cash on Deposit was verified by direct communication with the banks and reconcilement of the amounts reported to us with the balance shown by the books of the Society.

The Petty Cash kept in the New York Office was verified by count.

A summary of the cash accounts follows:

				Research	
	General Fund	Endowment Fund	F. Paul Anderson Medal Fund	Endowment Fund	Unrestricted Funds
ACTIVE					
Bankers Trust Co.	$13,390.39	$4,985.23			$11,598.32
Chase Nat. Bank	2,506.39				
Forbes Nat. Bank, Pittsburgh, Pa.					446.29
Bowery Sav. Bank	8,131.26				
Central Sav. Bank	7,261.19				
Dry Dock Sav. Inst.	5,607.86				
Emigrant Ind. Sav. Bank	7,782.69				
Bank for Savings			$1,108.27	$451.99	2,965.55
Provident Inst. for Sav., Boston, Mass.	3,482.33				
	$48,162.11	$4,985.23	$1,108.27	$451.99	$15,010.16
On Hand	100.00				50.00
	$48,262.11	$4,985.23	$1,108.27	$451.99	$15,060.16
FROZEN	500.00		$ 33.22	$213.53	

MARKETABLE SECURITIES

There is attached hereto a schedule of negotiable bonds which were verified by direct communication with the Bankers Trust Company where same are deposited for safekeeping. No adjustment has been made of the $2,616.36 shrinkage in the market value of these securities. These have been included in the attached Balance Sheet at cost.

ACCOUNTS RECEIVABLE

A list of the Membership Dues Receivable as of December 31, 1936, furnished to us by the management was checked to the individual ledger cards and found in agreement with the General Ledger Control. The unpaid dues may be summarized as follows:

Dues billed in 1936	$ 6,141.71
Dues billed in 1935	1,880.00
Dues billed in prior years	6,456.56
TOTAL	$14,478.27

Amounts due from Guide Advertisers and Other Accounts Receivable verified by trial balance of the individual ledger accounts were found in agreement with the General Ledger Control.

The sum of $2,066.19 has been added to the Reserve for Dues Doubtful of Collection, making a total Reserve of $9,417.19. Uncollectable Guide Advertisements and Other Receivables amounting to $535.88 have been written off, leaving a balance of $1,964.12. It is our opinion that the Reserves now on the books are sufficient to cover any further losses from realization.

INVENTORIES

Items appearing under this caption are based upon quantities submitted by the management and computations made by us. The Transactions Inventory priced at cost may be summarized as follows:

Prior Years	$1,811.06
1931	404.67
1932	433.29
1933-34	722.09
TOTAL	$3,371.11

FURNITURE, FIXTURES AND LIBRARY

Furniture, Fixtures and Library are shown herein at the book values without appraisal by us; we did, however, provide for depreciation of Furniture and Fixtures at the rate of ten (10%) per cent per annum.

ACCOUNTS PAYABLE

On December 31, 1936, there remained unpaid invoices amounting to $446.96, also the sum of $10,960.00 estimated by the management necessary to complete and make the first mailing of THE 1937 GUIDE.

PAYABLE TO RESEARCH FUND

The amounts due the Research Fund representing 40 per cent of Members and Associates dues were determined from computations made by us in accordance with Section 5, Article 3, of the By-Laws.

ACCRUED ACCOUNTS

Additional compensation to the Secretary and the clerical staff of the Society has been computed in accordance with the instructions of the Finance Committee.

RESERVE FOR PUBLICATIONS

There has been reserved the sums of $3,000.00 and $3,500.00 respectively for publication of Volumes 41 and 42 of Transactions. These provisions have been made in accordance with Council Authorization.

DEFERRED INCOME

Members Prepaid Dues were ascertained by trial balance of the individual ledger cards. Prepaid Dues from Proposed Members were verified from inspection of the applications found on file.

RESERVE FOR ENDOWMENT FUND ADJUSTMENT

The original appropriation of the Endowment Fund of $19,641.18 shows an actual reduction in principal of $3,277.90 due to losses incurred from the Sales of Securities. In addition there exists a shrinkage in market value of securities now in portfolio of this Fund amounting to $2,796.05. The Council in order to replenish the Fund to its original amount and to provide for the losses aforementioned at a meeting held on January 27, 1936, has authorized the setting aside out of 1935 income the sum of $7,500.00.

GENERAL FUND

There is attached hereto a schedule showing the changes that have occurred in the General Fund during the calendar year 1936.

SPECIFIC FUND

The specific funds are shown on the attached Balance Sheet after adjustment for interest earned and appropriations authorized by Council.

Operations of the Research Funds for the calendar year 1936 are detailed in schedules attached hereto.

OPERATIONS

There is attached hereto Statements of Income and Expenses for the calendar year 1936 showing a net income of $3,445.98 from Society activities and $17,182.98 from Guide Operations. In the preparation of these statements 30 per cent of the Salaries and Office Overhead expenses have been allocated to Guide Operations in the attached statements.

SPECIAL APPROPRIATIONS

The appropriation of $3,000.00 for the New York Academy of Medicine Cooperative Project has not been set up on the books by us in view of the fact that the required outside contributions have not been received.

Respectfully submitted,
PUBLIC AUDIT COMPANY.
(Signed) FRANK G. TUSA,
CERTIFIED PUBLIC ACCOUNTANT.

BALANCE SHEET

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
NEW YORK, N. Y.
December 31, 1936

ASSETS

SOCIETY			
CASH			
On Deposit		$48,162.11	
On Hand		100.00	
In Closed Bank		500.00	$48,762.11
INVESTMENTS (AT COST)			
Securities (Market Value $11,705.00)		11,525.31	
ADD: Accrued Interest		61.46	11,586.77
ACCOUNTS RECEIVABLE			
Membership Dues	$14,478.27		
LESS: Reserve for Doubtful	9.417.19	5,061.08	
Advertisers and Sundry Debtors	23,328.31		
LESS: Reserve for Doubtful	1,964.12	21,364.19	26,425.27
INVENTORIES			
Transactions		3,371.11	
Emblems and Certificate Frames		77.05	
Postage		360.72	3,808.88
PERMANENT			
Library		300.00	
Furniture and Fixtures	5,865.21		
LESS: Reserve for Depreciation	4,879.37	985.84	1,285.84
DEFERRED CHARGES			
Chapter Meeting Allowance			500.00 $92,368.87
SPECIFIC FUNDS			
ENDOWMENT FUND			
Cash on Deposit			4,985.23
Securities at Cost (Market Value $9,122.60)		11,918.65	
ADD: Accrued Interest		111.35	12,030.00 17,015.23
F. PAUL ANDERSONAWARD FUND			
Cash on Deposit			1,108.27
Cash in Closed Bank			33.22 1,141.49
RESEARCH FUND			
ENDOWMENT FUND			
Cash on Deposit		451.99	
Cash in Closed Bank		213.53	665.52
UNRESTRICTED FUNDS			
Cash on Deposit		13,154.82	
Cash on Hand		50.00	
Cash on Hand for Deposit		1,855.34	15,060.16 15,725.68
			$126,251.27

LIABILITIES AND CAPITAL

SOCIETY			
ACCOUNTS PAYABLE			$11,406.96
PAYABLE TO RESEARCH FUND			
On Dues as and when Collected			2,397.53
ACCRUED ACCOUNTS			
Compensation—Secretary and Staff			2,250.41
RESERVE FOR PUBLICATIONS			
Transactions Vol. 41 and 42			6,500.00
DEFERRED INCOME			
Prepaid Dues—Members		$1,109.11	
Prepaid Dues—Proposed Members		1,149.68	2,258.79
RESERVE FOR ENDOWMENT FUND REPLENISHMENT		7,500.00	
TOTAL LIABILITIES		32,313.69	
GENERAL FUND			
Society		60,055.18	$92,368.87
SPECIFIC FUNDS			
ENDOWMENT FUND			
Principal		16,363.28	
Unexpended Income		651.95	17,015.23
F. PAUL ANDERSON AWARD FUND			
Principal		1,000.00	
Unexpended Income		141.49	1,141.49
RESEARCH FUND			
ENDOWMENT FUND			
Principal	600.00		
Unexpended Income	65.52	665.52	
UNRESTRICTED FUND			
Balance—January 1, 1936	8,178.62		
Excess of Income over Expenses for the Year Ended December 31, 1936	6,881.54	15,060.16	15,725.68
			$126,251.27

NOTE "A"—This Balance Sheet is subject to the comments contained in the letter attached to and forming a part of this report.

BUDGET COMPARISON

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
NEW YORK, N. Y.
For the Calendar Year Ended December 31, 1936

INCOME

	Actual	*Budget Provision*	*Increases Decreases*
Membership Dues	$20,567.39	$20,000.00	$ 567.39
Profit—Emblem and Certificate Frames Sales	77.27	100.00	22.73
Journal Reprints, Books, etc.	304.19	250.00	54.19
Transactions	1,636.06	750.00	886.06
Editorial Contract	12,858.37	12,800.00	58.37
Interest on Reserve and Current Funds.	908.84	600.00	308.84
Guide Advertising and Copy Sales	56,525.49	48,000.00	8,525.49
	$92,877.61	$82,500.00	$10,377.61

EXPENSES

COST OF GUIDE			
Printing and Binding	$15,700.00	$16,500.00	$ 800.00
Mailing Expense	1,400.00	3,500.00	2,100.00
Paper Cost	3,955.02	3,500.00	455.02
Cuts, Engraving, etc.	642.18	500.00	142.18
Advertising Sales Cost	3,184.20	2,500.00	684.20
Copy Sales Cost	3,248.16	5,000.00	1,751.84
Editorial Service	3,000.00	3,000.00	.....
	$31,129.56	$34,500.00	$ 3,370.44
GENERAL SOCIETY ACTIVITIES			
Contribution A. S. A.	$ 50.00	$ 50.00	.....
Secretary and Staff Salaries	17,654.44	16,500.00	$ 1,154.44
Printing Codes	34.56	250.00	215.44
Subscriptions	3,155.41	5,000.00	1,844.59
General Printing	788.90	500.00	288.90
Postage	1,836.34	2,500.00	663.66
Meetings	1,409.75	1,500.00	90.25
Chapter Allowance	1,000.00	1,000.00	.....
Travel—Secretary and Staff	1,336.52	1,000.00	336.52
President's Fund	1,292.96	1,500.00	207.04
Rent and Light	2,598.78	2,700.00	101.22
General Office Expense	687.73	600.00	87.73
Office Supplies	386.70	500.00	113.30
Furniture and Fixtures	564.95	200.00	364.95
Telephone	524.72	500.00	24.72
Telegraph	277.73	300.00	22.27
Multigraphing	345.57	400.00	54.43
Professional Services	400.00	500.00	100.00
Awards, Members Certificates and Medals	416.37	350.00	66.37
Bank Charges	57.05	350.00	292.95
Yearbook	976.57	1,000.00	23.43
Transactions—1935	3,500.00	3,500.00	.....
Special Appropriations	1,824.43	5,000.00	3,175.57
	$72,249.04	$80,200.00	$ 7,950.96

Report of Membership Committee

The report of the Membership Committee was given by W. A. Russell, chairman, Kansas City, who said that the membership increase for the year totaled 469 members and that the present status of Society membership was at an all time high.

Honorary Members	3
Presidential Members	25
Members	1,356
Associate Members	540
Junior Members	357
Student Members	91
	2,372

Report of Committee on Research

W. A. Danielson, Washington, D. C., chairman of the Committee on Research, gave the report of the committee and prefaced his presentation with a statement that finances were improving, a number of new committees had been organized, and that a very active research campaign was contemplated for the coming year. (Complete Report of the Committee on Research appears in the February, 1937, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 126).

J. Lawrence DeNeille, St. Louis, Mo., former president of the *Heating, Piping and Air Conditioning Contractors National Association,* gave a brief word of greeting.

At the request of the president of the *Heating, Piping and Air Conditioning Contractors National Association* I am here to extend to you the cordial greetings of the national association, and best wishes for a most successful meeting.

For many years these two organizations have worked together for the advancement of the industry. At times, we have differed, but that is not strange, because our viewpoints must of necessity differ, but regardless of these differences we have had enough recognition of our common interests, on both sides, so that these differences never had a chance to wreck the continued cooperation of the two groups. In fact, we have usually come through our arguments, as any family should, drawn more closely together by a mutual recognition of the other fellow's reasons for his stand on any question under discussion.

It is pleasant to be chosen to bring you the greetings of the contractor group. It gives me a chance to meet many old friends and to say to you that we, as contractors, appreciate the contributions you engineers are making to the solutions of the problems of the industry. We have expressed our confidence by the overlapping memberships.

We are in a changing world, a world in which our customer of today is demanding a degree of comfort which was not only impossible, but undreamed of some years ago. Our job, as contractors, is to sell and install the apparatus which will produce the desired comfort. Your job, as engineers, is to devise ways and means of providing it, both through development of new apparatus and of new applications of existing equipment. If we do our job well the public will derive the benefit in a greater and more healthful comfort. We, as contractors, pledge our support to you and to the public.

I would be very neglectful of my duty as representative of our national association if I did not avail myself of this opportunity to extend to you a most cordial invitation to join us at our annual meeting in Minneapolis in May. We are holding our 48th Annual Convention at the Hotel Nicollet during the week of May 17. You will, all of you, be most welcome at that meeting.

Again, in closing, I extend you our greetings and best wishes for a profitable meeting.

The secretary of the Society, A. V. Hutchinson, New York, presented the Report of the Council and the Report of the Secretary.

Report of Council

Since the 42nd Annual Meeting, the Council has held four meetings, one in Chicago, two at Buck Hill Falls, Pa., and one in St. Louis, Mo.

At the meeting on January 30, 1936, the Council organized and appointed its Committees, approved a new Journal contract, selected St. Louis as the place for the 43rd Annual Meeting, approved depositories for Society funds, adopted the Budget for 1936 and appointed a new Certified Public Accountant; proposed a sub-committee on Air Conditioning Standards and authorized a survey on the relationship of air conditioning and public health.

At the June meetings, it was arranged to authorize payment of railroad expense for one executive officer selected by each Chapter as an official delegate to the Annual Meeting in St. Louis and arrangements were made for appointment of a Joint Committee by the Society and the *A. S. R. E.* to participate in the formation of a Code for Minimum Requirements of Comfort Air Conditioning.

The invitation of the Massachusetts Chapter to act as hosts for the Semi-Annual Meeting 1937 was accepted and it was decided to have the Society's 44th Annual Meeting during the fourth week of January, 1938, in New York, when the 5th International Heating and Ventilation Exposition will be held.

The Council authorized new advertising rates for THE GUIDE effective July 1, 1936, and appointed Ralph F. Duysters to the staff in accordance with the request of the Guide Publication Committee.

The Council made available a fund of $4000 to the Committee on Research for an enlarged program and appropriated $3000 for a cooperative program with the New York Academy of Medicine provided a similar amount could be obtained from other sources to study the relationship of air conditioning and health. The Council nominated five members to serve on the Committee on Research for a term of 3 years.

The Council received a report from the special committee studying the relationship of the A. S. H. V. E. and *A. S. R. E.* and recommended that this Committee continue its work. The request of several Chapters that assistance be given to local organizations by the Society was considered and referred to the incoming Council.

The Council has carried on the business activities of the Society through the Officers and Committees and is glad to report that membership is at a peak figure through the addition of 490 new members this past year; that the finances are in excellent condition and that Charters have been granted for new chapters in Montreal, Oklahoma City, and Texas.

Routine action was taken in connection with the resignations offered by members and cancellations of membership for non-payment of dues as required by Article B-II, Section 2. Life membership has just been granted to four members as follows: F. C. Black, R. L. Gifford, J. G. Hayes, F. W. Powers.

The Society has enjoyed a most successful year and plans are under way for enlarged activities for 1937.

Respectfully submitted,
THE COUNCIL.

Report of the Secretary

A brief review will be given of the major activities carried on at the headquarters office during the year just past. These activities include membership service, editorial, advertising, and sales promotion of publications, committee organization, and general administrative work.

A substantial increase in membership has been recorded through the successful work of the Membership Committee and Chapter cooperation. The present status is: Honorary Members 3, Presidential Members 25, Members 1,356, Associate Members 540, Junior Members 357, and Student Members 91.

Three new Chapters have been organized and some assistance has been rendered by the national officers and the staff in supplying speakers.

The employment service has been an active department involving heavy correspondence and the placement of many members. Members interested in obtaining employment are urged to use this service.

Technical committee activities and editorial work have been carried on effectively by Mr. James and sales promotion for THE GUIDE was most successfully done by Mr. Duysters.

The 1937 edition will soon be ready for distribution and this volume will be the largest and most widely circulated of any previous edition.

Two meetings were held in 1936—the 42nd Annual Meeting in Chicago set a record for attendance and the Semi-Annual Meeting at Buck Hill Falls jointly held with the *A. S. R. E.* was exceptionally well attended.

The members of Illinois and Philadelphia Chapters deserve great credit for their work as hosts on these occasions.

During the year there has been an increase in the volume of work in membership, meetings, publications, employment, publicity, and collections and all of this was handled without much additional personnel. Credit is due the members of the headquarters staff for their cooperation and I am glad of this opportunity to publicly express my appreciation.

For the mass of administrative details it might be significant to point out that the number of letters sent out on work exclusive of publications exceeded 20,000, sales promotion campaigns required mailing over 75,000 pieces. More than a carload of paper was used for THE 1937 GUIDE and if the books were placed end to end the distance covered would be a line of books nearly 2 miles long.

The Membership Committee's report will reveal that the increase this year has meant a full time job to carry out all the details of electing 490 members.

The Finance Committee report indicates a business of the Society of nearly $100,000 exclusive of research. The Guide Committee will advise you of a successful year's operations and it can be concluded that the Society is in a flourishing condition and has enlarged opportunities for service to the profession of Heating. Ventilating and Air Conditioning in 1937.

Respectfully submitted,
A. V. HUTCHINSON, *Secretary.*

President Larson announced the first technical paper and introduced Prof. F. B. Rowley, Minneapolis, Minn., who presented the paper, Thermal Properties of Concrete Construction by F. B. Rowley, A. B. Algren and Robert Lander. (Complete paper published in November, 1936, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 621).

R. A. Miller, Pittsburgh, inquired about the composition of concrete blocks *15a* and *b* listed in Table 1 and Prof. L. G. Miller, E. Lansing, Mich., wished to know about the control of the vapor pressures when blocks were subjected to a fog spray. W. A. Danielson inquired whether difficulties had been experienced in getting contact between a hot plate and the block. Replies to the questions were given by the author.

First Vice-Pres. D. S. Boyden, Boston, assumed the chair and introduced Prof. G. L. Tuve, Cleveland, who presented the paper, the Specific Characteristics of Fans, by M. C. Stuart and J. B. Lusk. (Complete paper published in September, 1936, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 507). Written discussions by Prof. R. L. Perry, University of California, and Prof. J. R. Weske, Case School of Applied Science, were presented by John James, New York, and replies to discussions prepared by Professor Stuart were given by Professor Tuve. Comments were also made by S. H. Downs, Kalamazoo, Ernest Szekely, Milwaukee, and W. A. Rowe, Detroit.

The report of the tellers was presented by Secy. A. V. Hutchinson as follows.

Report of Board of Tellers

The votes cast for Officers have been tabulated by your Board of Tellers with the following results:

President—D. S. Boyden.....595
First Vice-President—E. H. Gurney.....595
Second Vice-President—J. F. McIntire.....594
Treasurer—A. J. Offner.....595

Members of the Council—3 year term:

J. J. Aeberly.....594
M. C. Beman.....595
E. O. Eastwood.....594
W. A. Russell.....595

The votes cast for Members of the Committee on Research have been tabulated by the Board of Tellers with the following results:

Three year term:

H. E. Adams.....595
A. E. Stacey.....595
G. L. Tuve 595
J. H. Van Alsburg.....593
J. H. Walker.....595
W. G. Boales..... 1

Total number of legal votes cast.....595
Invalid 45

640

Respectfully submitted,
R. H. CARPENTER, *Chairman,*
R. V. SAWHILL,
F. E. W. BEEBE.

President Larson introduced Capt. R. L. Reiss, London, who presented a lantern slide talk on Government Housing Projects in England.

The government department in Great Britain that is responsible for housing is the Ministry of Health. The Minister of Health is a member of the Cabinet and under him is a large department divided in various divisions in which housing is one, town planning is one, and various other plans of public health are in other divisions. It also includes various other activities which are not strictly health questions but which the local municipal authorities have to deal with.

So, I want you to understand that the Ministry of Health is the government department which sees that the municipal authorities carry out the duties imposed on them by the legislation which Parliament has passed.

Applying that to housing, Parliament having passed a law which says that the individual municipal authorities are responsible for seeing that the housing of the lower paid workers is improved, it is then necessary to have a government department that sees that they do it, and that department is the Ministry of Health.

In order to enforce the law, we don't employ actual physical force upon the members of the local housing authorities, though sometimes some of us feel inclined to do it in regard to some of them. We have used what is, perhaps, the sweeter way of doing it and the more effective way, and that is to make it conditional. The grants which are obtained from the central government (the national), for the various things the local municipality has to do, are conditional on them doing the work properly so any municipal authority that is not carrying out his duties knows that he runs the risk of losing the grant from the national government, and as money is still important on both sides of the Atlantic, we find this is an effective way of doing it.

The local municipal authority is elected every three years and it appoints from amongst its number, a committee or commission for various different purposes, and whole series of different committees, and one of those, in most authorities, is called the Housing Commission, but in some it combines with the Housing

and Public Health Commission. That is very significant because it shows that housing is linked with public health. In London it is called a Housing and Public Health Committee.

That actually functions in the following way: There is a department of the Medical Officers of Health employed by the municipal authority—I think you call them Health Commissioners, I am not quite sure—it is the duty of that official and the assistant doctors under him to inspect the various houses, particularly the low rent houses, in the whole district, and report as to their condition to the Housing Committee, and they bring up, first of all, individual houses that ought to be demolished because they are unfit for human habitation or unhealthy and, sectionally, they report on areas where the only way of improving is to tear them down altogether.

If this Committee is satisfied upon a certain report, they make an order called a clearance order. The owners have a right of appeal to the Ministry of Health, the central government department, and, if necessary, an inspector is sent down from the national government. If the inspector reports to the Minister of Health that what the local authorities are proposing to do is correct, then the procedure goes ahead. They have power to make it compulsory. They only pay for the value of the land, not for the building upon it unless those buildings are, individually, satisfactory ones.

Sometimes you have good houses in amongst all the bad ones, but if the house, itself, is bad then the owner gets nothing for the house but only for the site, on the same principle that anyone who has bad meat that has been condemned gets no compensation because that meat has gone bad.

Then, the next stage is that the architect of that local authority prepares a redevelopment plan with the layout of the plan and the design of the buildings. That, again, is brought before the Housing Authority. They may be satisfied with it or they may suggest alterations or amendments, and then in the next stage, it goes out for bids from contractors, from various private contractors, for the erection of the dwellings.

At that stage, the local Housing Authority has to submit the price up to the government department and apply for permission to raise a loan for the purpose of carrying that scheme out. If it is approved for the purpose of the loan, then the local Housing Committee can either borrow directly through its own stock, or it can borrow from the government.

The next and final stage is when the houses are completed, the next official of the Authority, who is responsible for the management of the property, submits his proposal for the rents for the different sized dwellings, and if that is sanctioned, he proceeds with the letting of the dwellings. First consideration is given to those who have been displaced from slums that are being pulled down, for it is the duty of the Authority to rehouse those people who have been displaced.

I think that gives you as clearly as I can, recognizing that your procedures are different, the precise method in which we do it. From the start we have made it a local responsibility for carrying out the work, but the national government has given the financial assistance in order to enable it to be carried out.

Before you can start clearing away the slums, you must have somewhere to put the people who are being moved out of the slums, and therefore we have to select certain areas, some land not at present occupied, and build some apartments on that so you can move the people from the slum area nearby into those, and then you can get ahead with redeveloping that, and move into that area, people from a third area that is then going to be done. We do find some large houses, built about 150 years ago, that had large gardens. These houses are no longer useful and are torn down. Then we build these apartment dwellings, trying as far as possible to keep the trees that were in the garden. This is an example. (Showed slide.)

Well, I thought those might possibly interest you, showing in practice the way we have been trying to deal with the problem. If anyone would like to ask any questions, I will be glad to try to answer them.

The appreciation of the members was expressed to Captain Reiss by President Larson, after which the session adjourned.

SECOND SESSION—

Tuesday, January 26, 1937, 9:30 A. M.

The second session of the meeting was called to order by President Larson on Tuesday morning and O. W. Ott, Los Angeles, member of the Committee on Constitution and By-Laws, gave the report of the committee.

Report of Committee on Constitution and By-Laws

The work of the Committee on Constitution and By-Laws included review of the By-Laws of several local Chapters and the preparation of an amendment to Article B-II, Section 5 relating to Life Membership.

J. H. Walker, Detroit, chairman of the Guide Publication Committee, was introduced and presented the following report:

Report of Guide Publication Committee

It is a pleasure to report that THE GUIDE is now on the press and will be distributed to the members in a very few days. This year the policy of the Committee was to completely revise about one-third of the book with the thought that if this were done every year, a completely new GUIDE would be available every three years.

The important changes in the 1937 edition were in the chapters on the Physical and Physiological Principles of Air Conditioning; Humidification, Dehumidification and Water Cooling Equipment; Automatic Control; Sound Control; Air Distribution; Gravity and Mechanical Warm Air Furnace Systems; Chimneys and Draft Calculations; Drying Systems, and revisions were made in several other chapters.

We revised altogether a total of nine chapters and made minor revisions in possibly nine or ten more. The size of the book has been slightly increased with the total text pages in the 1937 edition numbering 808 as compared with 792 pages for last year. The advertising in the catalog data section shows an increase of 20 per cent from 262 pages to 316 pages. Last year 12,400 copies of THE GUIDE were printed and this year 14,500 copies have been ordered to fill additional requests.

I want to say a word about the suggestions that you submit on the card that is enclosed each year with THE GUIDE. The Committee welcomes suggestions for THE GUIDE, but you may find that your suggestion has not always been adopted. If it has not, it is probably due to one of two things, either you have suggested something that is outside of the scope of THE GUIDE, or else you have asked for something on which there are no data. The Guide Committee cannot go out and create its own data. It has to take material that the Research Committee or the other Society committees have built up, so do not feel hurt if your suggestion has not been embodied in THE GUIDE. It certainly has been given full consideration.

I want to acknowledge the very fine assistance of Mr. James of the Society office. He bore the brunt of the editorial and proofreading work and was of great help to the Committee. The work of the Committee has been made much easier by having Mr. James working on it. I want to express my appreciation to the members of the Committee, they all worked very hard. Mr. Chairman, the Committee presents THE GUIDE.

Guide Publication Committee,
J. H. WALKER, *Chairman.*

The first technical paper, A Rational Method of Duct Design, by Prof. L. G. Miller, was presented by the author. (Complete paper published in February, 1937, A.S.H.V.E., Journal Section, *Heating, Piping and Air Conditioning,* p. 121).

The paper, Noise Characteristics of Air Supply Outlets, by D. J. Stewart and G. F. Drake, was given by Mr. Stewart and questions were asked by Messrs. H. M. Hart, Chicago, S. H. Downs, and J. H. Van Alsburg, Chicago, and were answered by the authors, Messrs. Stewart and Drake. (Complete paper published in January, 1937, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 65.).

The final paper of the morning session, The Nature of Noise in Ventilating Systems and Methods for Its Elimination, by J. S. Parkinson, was presented by J. R. Patterson, St. Louis. (Complete paper published in March, 1937, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 183.) Questions were asked by Prof. A. I. Brown, Columbus, O., Mr. Wolfe, D. J. Stewart, Rockford, Ill., G. F. Drake, Rockford, Ill., R. K. Werner, Fort Worth, Tex., E. K. Campbell, Kansas City, M. D. Kiczales, Washington, D. C., and W. A. Rowe, Detroit.

Messages of greeting were read from E. H. Gurney, Toronto, first vice-president of the Society, en route home from London from a round the world trip, and from Allen W. Williams, managing director, *National Warm Air Heating and Air Conditioning Association.*

W. T. Jones, Boston, Mass., past president of the Society, said that never before had the Society held a meeting when a disaster of the magnitude of the present flood threatened to destroy cities where members of the Society had homes or business interests. He was presenting the suggestions of several members who believed that some tangible evidence of sympathy for the flooded area be extended through the local St. Louis Chapter. Mr. Jones then presented the following resolution:

That, the representatives of the American Red Cross St. Louis Chapter be permitted to collect any contributions that might be offered by the members assembled at this meeting.

The motion was seconded by T. H. Urdahl, Washington, D. C.

As a result of the collection $162.00 was presented to the St. Louis representative of the Red Cross.

The session then adjourned.

THIRD SESSION—

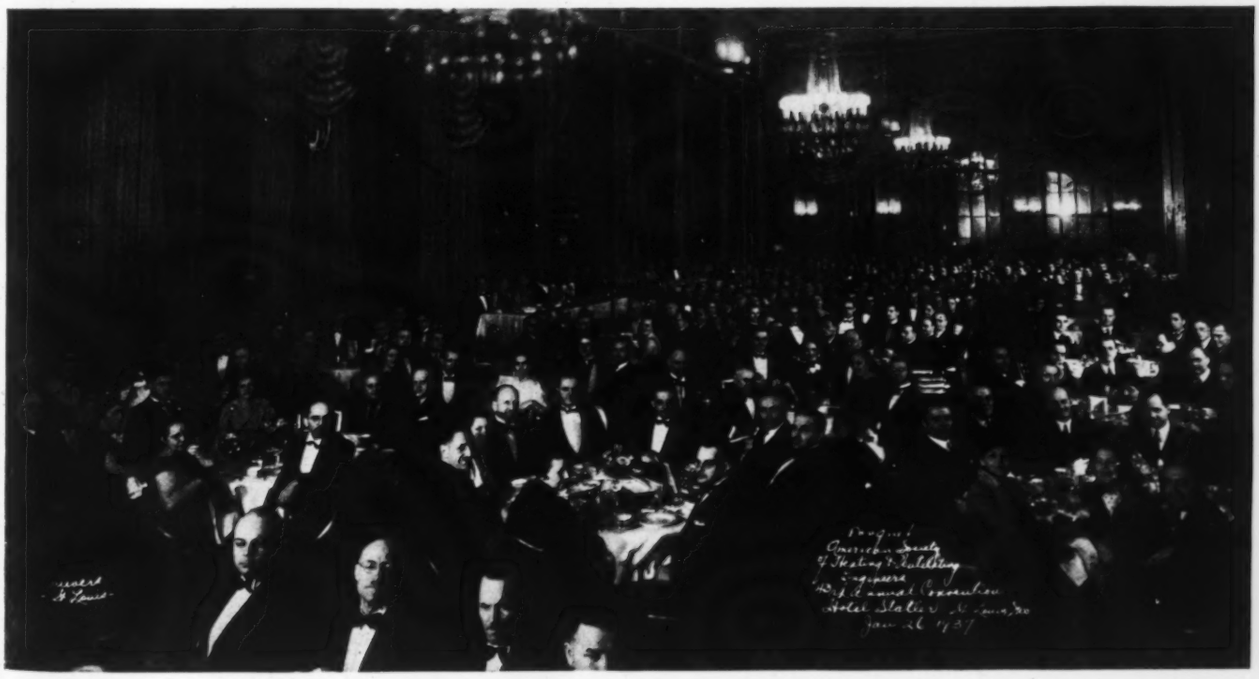
Tuesday, January 26, 1937, 2:00 P. M.

On Tuesday afternoon President Larson opened the third technical session at 2:00 p. m. and introduced Dr. Charles Sheard, Rochester, Minn., who presented the paper, Investigations on the Exchanges of Energy Between the Body and Its Environment, by Dr. Charles Sheard and Dr. M. M. D. Williams. (Complete paper published in March, 1937, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 189.)

A long discussion followed this paper in which the participants were Dr. E. V. Hill, Chicago, Dr. Munson, J. B. Steele, Winnipeg, W. A. Danielson, Washington, D. C., F. C. Houghten, Pittsburgh, W. R. Knudsen, Chicago, W. R. Beach, Cleveland, D. J. Stewart, and Dr. Sheard.

The paper, Fever Therapy Induced by Conditioned Air, by F. C. Houghten, Dr. M. B. Ferderber and Carl Gutberlet, was presented by Mr. Houghten. (Complete paper published in February, 1937, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 115). Comments were made by Dr. Sheard and a reply was given by Mr. Houghten.

The report of the A.S.H.V.E., *A.S.R.E.* Committee on National Standards for Air Conditioning Applications was presented by John Howatt, Chicago.



The 43rd Annual Banquet of the A. S. H. V. E., Hotel Statler, St. Louis, Mo., January 26, 1937

Report of A.S.H.V.E.-A.S.R.E. Committee on National Standards for Air Conditioning Applications

At the joint convention held last summer, in Buck Hill Falls, the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the *American Society of Refrigerating Engineers* were authorized, in the presence of these two Societies, to appoint a Committee to serve jointly in the preparation of national standards or code for air conditioning applications.

The presidents of the two societies, G. L. Larson and L. S. Morse, appointed a Committee consisting of ten. The Committee had its original meeting in Pittsburgh at which L. A. Harding was chosen as chairman. As President Larson told you, the presentation of this report was to have been made by Mr. Harding, but he is home, ill in bed, and could not attend the Annual Meeting.

At that original meeting in Pittsburgh, a full attendance was had and the tentative draft of standards prepared. The Committee has had several meetings since, two in Buffalo, and each of those meetings resulted in revisions, additions and deletions to the original draft until, today, we have what we believe is a set of standards that is fairly comprehensive and covers in a general way the requirements of comfort air conditioning in North America. However, the work of the Committee is not completed. This fourth revision needs more discussion.

All we can report, today, is that we believe this Committee has progressed a considerable distance in this work, and we know that the work of the Committee will have to be continued, for a part at least, through 1937. The report we are making, then, is a report to you that the Committee is working and making progress and will have to be continued further.

President Larson asked Mr. Houghten to present the paper, Cooling Requirements for Summer Comfort Air Conditioning, by F. C. Houghten, F. E. Giesecke, C. Tasker and Carl Gutberlet. (Complete paper published in December, 1936, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 681).

W. E. Stark, Cleveland, presented a written discussion and Mr. James read prepared comments of E. W. Gray, Oklahoma City, G. B. Helmrich, Detroit, F. J. Linsenmeyer, Detroit, and written discussions from members of Minnesota Chapter, Philadelphia Chapter, and Cincinnati Chapter. Additional comments were given by Dr. C. A. Mills, Cincinnati, W. L. Fleisher, New York, Dr. E. V. Hill and a reply to the discussions was given by Messrs. Tasker and Giesecke.

The session then adjourned.

FOURTH SESSION—

Wednesday, January 27, 1937, 9:30 A. M.

The final session of the 43rd Annual Meeting of the Society was called to order by President Larson, who announced that the registration total 503.

The paper, Heat Losses and Efficiencies of Fuels in Residential Heating, by R. A. Sherman and R. C. Cross, was presented by Mr. Cross, Columbus, O. (Complete paper published in January, 1937, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 53.). A written discussion was prepared by Prof. L. E. Seeley, New Haven, Conn., and comments were made by W. E. Stark, L. C. Price, R. J. Bender, and H. P. Reid.

The paper, Performance of Oil-Fired, Warm-Air Furnaces in the Research Residence, by A. P. Kratz and S. Konzo, was presented by Mr. Konzo, Urbana, Ill. (Complete paper published in December, 1936, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 693.). Comments were made by Messrs. Price and Langenberg.

The subject of Condensate and Air Removal Rates in a Vacuum Heating System, by D. W. Nelson, Madison, Wis., was presented by the author. (Complete paper published in October, 1936, A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning,* p. 561.). Comments were offered by H. E. Adams, Norwalk, Conn.

Installation of Officers

W. T. Jones, Boston, past president of the Society, was requested to conduct the installation of officers. President-elect D. S. Boyden, Boston, was instroduced by W. H. Driscoll, New York. Second Vice-Pres. J. F. McIntire, Detroit, was introduced by F. B. Rowley, Minneapolis, and A. J. Offner, treasurer, New York, was presented by Mr. Jones.

The new members of the Council, M. C. Beman, Buffalo, W. A. Russell, Kansas City, and J. J. Aeberly, Chicago, were presented by Mr. Jones.

President Boyden assumed the chair and introduced J. E. Hillemeyer, St. Louis, former president of the *National District Heating Association,* who presented greetings from that body.

Resolutions

The report of the Resolutions Committee was presented by G. L. Wiggs, Montreal, who moved the following resolutions:

WHEREAS, this, the 43rd Annual Meeting of the Society, has been so eminently successful, not only in the great interest and the valuable contributions of the papers presented by the various authors, and in the splendid entertainment provided by the St. Louis Chapter, but in the delightful surroundings in which the Convention is being held, and especially in the spirit of informality and warm friendship which has been so evident throughout the whole of the meeting,

BE IT, THEREFORE, RESOLVED that the thanks and appreciation of the Society be given:

To each of the *authors* of the various papers for their splendid contributions to the knowledge and literature of the Society,

To the *St. Louis Chapter* and its various committees for the successful way in which they planned, organized and conducted this Annual Meeting,

To the *St. Louis Convention Bureau* for their cooperation and untiring efforts,

To *Dr. A. C. Willard* for his inspiring address at the Annual Banquet,

To the management and staff of *Hotel Statler* for the splendid accommodation and attentive service which they provided,

To the daily and trade *Press* for the attendance of their representatives and for the publicity which they have given to the Meeting,

To *Radio Station KSD* for the time which they so graciously contributed so as to allow one of our Past Presidents to make a broadcast on air conditioning, and

To the *American Rolling Mill Company* for their courtesy in having President Larson as guest speaker on their program in the broadcast over the net work of the National Broadcasting Company.

On motion of Mr. Wiggs, seconded by Mr. Russell, the resolutions were adopted.

President Boyden called for any unfinished business and inquired if any new business was to be brought before the meeting. Upon hearing no response, the meeting adjourned at 12:30 p. m.

Ladies on Tour of St. Louis

Entertainment

The entertainment program provided enjoyment for every member, guest and lady during the three days of the meeting. The Committee on Arrangements of the St. Louis Chapter was on hand to greet the arriving members on Sunday, January 24, and the St. Louis Room in the Hotel Statler was the gathering place for all.

At noon on Monday a Get-Together Luncheon was held in Parlor A and 180 listened to an interesting talk entitled, How Europe Solves Its Housing Problems by Capt. R. L. Reiss of London.

On Monday evening at 7:00 p. m. members, guests and ladies attended the Mississippi Levee Levities on the roof garden of the Hotel Statler. A fine turkey dinner was served to 410 people, music for dancing was furnished by Al Roth's orchestra and during the evening 10 acts of variety entertainment amused the audience.

The ladies had a special program of entertainment and on Monday assembled in the Daniel Boone Room for tea and an interesting talk on precious gems. On Tuesday an auto trip to Shaw's Gardens, Jefferson Memorial where the Lindbergh trophies are housed and luncheon at Garavelli's provided the ladies with a full afternoon of fun.

Banquet

At 7:30 on Tuesday evening the doors of the ballroom opened and the Banquet was served to 350 diners. Between courses, vocal numbers were enjoyed and then the Toastmaster, E. B. Langenberg, announced that at 9:10 President Larson would be guest speaker on the Armco Hour over a coast to coast radio hook-up. The Ironmaster, Bennett H. Chapple, Vice President of the American Rolling Mill Co., introduced President Larson to the radio audience and he gave the following talk:

Thank you, Mr. Ironmaster. Today, everybody talks about air conditioning, but only a few seem to know that it is not a new or mysterious art. Air conditioning has celebrated its twenty-fifth anniversary. And so that you may better understand what it is I will quote the standard definition adopted by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. *"Air conditioning is the simultaneous control of all or at least three of the factors affecting both the physical and chemical conditions of the atmosphere within a structure. The factors are temperature, humidity, motion, distribution, dust, bacteria, odors and toxic gases."*

Scientific research sponsored by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, has developed the fundamental knowledge which engineers have used so successfully to bring comfort to our homes, thereby improving our modern standard of living. The future holds great promise for the development of air conditioning applications which will have a vital influence on public health. They may be an important factor in the treatment of diseases. The potential benefits are still unknown, but pioneer work is being done in laboratories, clinics and hospitals by noted scientists. They are studying the effect of atmospheric impurities, odors, of air flow and air distribution, air cooling and the treatment of air with electricity. The engineer, the physician and the chemist working together will solve the future problems of air conditioning.

Engineers have blazed the comfort trail, and the path to better health beckons those who desire to provide a more abundant life for more people. To meet one of today's problems in air conditioning which affects the public generally, our Society is preparing a code of uniform national standards outlining correct design methods and applications of air conditioning equipment so that you may be assured of satisfactory performance and enjoy real comfort. A new day has dawned for air conditioning. We are all in a responsive mood. Research and industry have accepted the challenge. Heating and ventilating engineers pledge that life in nineteen thirty-seven can be more enjoyable with modern air conditioning.

After the broadcast the toastmaster introduced John Howatt, Chicago, Past President of the Society, who in a graceful speech presented Prof. G. L. Larson with the Past President's emblem. President Larson responded briefly and gave the significance to him of the initials A S H V E.

The toastmaster introduced Dr. A. C. Willard, President of the University of Illinois, Past President of the Society, who gave an inspiring talk on The Engineer's Place in Modern Society.

President-elect D. S. Boyden of Boston was introduced and after expressing his pleasure for the honor conferred upon him, he presented a resolution adopted by the Council of the Society expressing appreciation for the services of F. C. Houghten, Director of the A. S. H. V. E. Research Laboratory.

The concluding entertainment feature of the meeting was the inspection trip, on Wednesday, January 27, of the Anheuser-Busch Power Plant and Brewery; 60 members and ladies made the trip.

The Committee in charge of arrangements spent many hours planning the program and acting as hosts to the visiting members and guests. The members of this Committee were as follows: C. R. Davis, General Chairman; L. W. Moon, Vice-Chairman; C. E. Hartwein, Finance; G. W. F. Myers, Banquet; R. J. Tenkonohy, Reception; P. W. Sodemann, Transportation; D. J. Fagin, Entertainment; E. E. Carlson, Publicity, and J. W. Cooper, Ladies.

W. H. Driscoll Joins Carrier Corporation

William H. Driscoll becomes vice president in charge of construction for Carrier Corp., Newark, N. J., according to an announcement of L. R. Boulware, vice-president and general manager. Mr. Driscoll will be in charge of all installations of Carrier equipment and he brings a wealth of experience having

W. H. Driscoll

been responsible for the installation of all mechanical systems for Thompson Starrett Co. During his many years of service as vice-president of Thompson-Starrett Co., Mr. Driscoll was in charge of heating, ventilating, air conditioning, refrigerating, plumbing and electrical work.

Mr. Driscoll received his early education in Jersey City, N. J., and at Cooper Union and Mechanics Institute in New York. He s a past president of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and for many years served on the Council and on many of its technical committees.

NEWS OF LOCAL CHAPTERS

OFFICERS OF LOCAL CHAPTERS—1937

CLEVELAND: *Organized,* 1916. *Headquarters,* Cleveland, O. *Meets,* Second Thursday in Month. *President,* L. T. AVERY, 2341 Carnegie Ave. *Secretary,* W. R. BEACH, 75 Public Sq.

CINCINNATI: *Organized,* 1932. *Headquarters,* Cincinnati, O. *Meets,* Second Tuesday in Month. *President,* E. B. ROYER, 6635 Iris Ave. *Secretary,* O. W. MOTZ, 920 E. McMillan St.

ILLINOIS: *Organized* 1906. *Headquarters,* Chicago, Ill. *Meets,* Second Monday in Month. *President,* J. J. HAYES, 53 W. Jackson Blvd. *Secretary,* C. E. PRICE, 6 N. Michigan Ave.

KANSAS CITY: *Organized,* 1917. *Headquarters,* Kansas City, Mo. *Meets,* Second Monday in Month. *President,* L. R. CHASE, 2440 Pennway. *Secretary,* F. J. DEAN, JR., 6028 Walnut St.

MANITOBA: *Organized,* 1935. *Headquarters,* Winnipeg, Man. *Meets,* Fourth Thursday in Month. *President,* J. B. STEELE, 184 Waterloo St. *Secretary,* C. H. TURLAND, 325 Centennial St.

MASSACHUSETTS: *Organized,* 1912. *Headquarters,* Boston, Mass. *Meets,* Second Tuesday in Month. *President,* JAMES HOLT, Massachusetts Institute of Technology, Cambridge, Mass. *Secretary,* JOHN TURNER, 285 Columbus Ave.

MINNESOTA: *Organized,* 1918. *Headquarters,* Minneapolis, Minn. *Meets,* Second Monday in Month. *President,* N. D. ADAMS, 220 Second Ave. S. W., Rochester, Minn. *Secretary,* J. E. SWENSON, 800 Hennepin Ave.

MICHIGAN: *Organized,* 1916. *Headquarters,* Detroit, Mich. *Meets,* First Monday after the 10th of the Month. *President,* R. K. MILWARD, 127 Campbell Ave. *Secretary,* G. H. TUTTLE, 2000 Second Ave.

WESTERN MICHIGAN: *Organized,* 1931. *Headquarters,* Grand Rapids, Mich. *Meets,* Second Monday in Month. *President,* L. G. MILLER, Mich. State College, E. Lansing, Mich. *Secretary,* E. I. ADAMS, 115 So. Pine, Lansing, Mich.

MONTREAL: *Organized,* 1936. *Headquarters,* Montreal, Que. *Meets,* Third Monday in Month. *President,* G. L. WIGGS, University Tower. *Secretary,* C. W. JOHNSON, 630 Dorchester St., W.

NEW YORK: *Organized,* 1911. *Headquarters,* New York, N. Y. *Meets,* Third Monday in Month. *President,* G. E. OLSEN, 101 Park Ave. *Secretary,* T. W. REYNOLDS, 100 Pinecrest Dr., Hastings-on-Hudson, N. Y.

WESTERN NEW YORK: *Organized,* 1919. *Headquarters,* Buffalo, N. Y. *Meets,* Second Monday in Month. *President,* P. S. HEDLEY, Curtiss Bldg. *Secretary,* C. A. GIFFORD, 247 North Dr.

OKLAHOMA CITY: *Organized,* 1935. *Headquarters,* Oklahoma City, Okla. *Meets,* Second Monday in Month. *President,* F. X. LOEFFLER, 1604 N. W. Fifth St. *Secretary,* E. W. GRAY, Box 1498.

ONTARIO: *Organized,* 1922. *Headquarters,* Toronto, Ont. *Meets,* First Monday in Month. *President,* THOMAS MCDONALD, 117 Peter St. *Secretary,* H. R. ROTH, 57 Bloor St. W.

PACIFIC NORTHWEST: *Organized,* 1928. *Headquarters,* Seattle, Wash. *Meets,* Second Tuesday in Month. *President,* S. D. PETERSON, 473 Colman Bldg. *Secretary,* D. C. GRIFFIN, Orpheum Bldg.

PHILADELPHIA: *Organized,* 1916. *Headquarters,* Philadelphia, Pa. *Meets,* Second Thursday in Month. *President,* W. F. SMITH, 422 Bryn Mawr Ave., Cynwyd, Pa. *Secretary,* H. H. ERICKSON, 804 Architects Bldg.

PITTSBURGH: *Organized,* 1919. *Headquarters,* Pittsburgh, Pa. *Meets,* Second Monday in Month. *President,* M. L. CARR, P. O. Box 1646. *Secretary,* T. F. ROCKWELL, Carnegie Inst. Tech.

ST. LOUIS: *Organized,* 1918. *Headquarters,* St. Louis, Mo. *Meets,* First Tuesday in Month. *President,* C. R. DAVIS, 2328 Locust St. *Secretary,* R. J. TENKONOHY, 3650 Shaw Blvd.

SOUTHERN CALIFORNIA: *Organized,* 1930. *Headquarters,* Los Angeles, Calif. *Meets,* Second Tuesday in Month. *President,* LEO HUNGERFORD, 524 Loew's State Bldg. *Secretary,* H. M. HENDRICKSON, 5051 Santa Fe Ave.

TEXAS: *Organized,* 1936. *Headquarters,* College Station, Texas. *President,* F. E. GIESECKE, Texas A. & M. College. *Secretary,* W. H. BADGETT, Texas A. & M. College.

WASHINGTON, D. C.: *Organized,* 1935. *Headquarters,* Washington, D. C. *Meets,* Second Wednesday in Month. *President,* W. A. DANIELSON, 2236 Munitions Bldg. *Secretary,* M. D. KICZALES, 3000 Connecticut Ave., N. W.

WISCONSIN: *Organized,* 1922. *Headquarters,* Milwaukee, Wis. *Meets,* Third Monday in Month. *President,* M. E. ERICKSON, 8405 W. Greenfield Ave., West Allis, Wis. *Secretary,* R. G. KOCH, 626 E. Wisconsin Ave.

Illinois Chapter Enjoys Lecture on Ancient Engineering Feats

February 8, 1937. The regular February meeting of the Illinois Chapter was given over to a dinner, lecture and dance to which the wives of members and guests were invited, and which was held in the Louis XVI Room of the Hotel Sherman, Chicago. Eighty-seven members and guests attended.

After dinner the regular order of business was dispensed with and Pres. J. J. Hayes immediately introduced Vice-Pres. L. S. Ries who presented the speaker of the evening, Dr. Watson Boyes, secretary, Oriental Institute, University of Chicago. Dr. Boyes gave a very interesting illustrated lecture on Engineering Feats of the Ancient Near Eastern People.

The discussion covered the quarrying, transportation and erection of Egyptian obelisks, or Cleopatra's needles, as they are called. These obelisks, ranging in weight from 100 tons to 500 tons, were handled by sheer man power and the inclined plane in the absence of any devices other than the lever, known to the ancient oriental world. Among other engineering feats described was the ancient water supply system at Megiddo, Palestine. It was obvious from Dr. Boyes' lecture that hundreds of years B. C. there was a civilization capable of feats of engineering and construction comparing favorably with those of the present day.

After the lecture there was dancing to the music of George Konchar and his orchestra, and Secy. C. E. Price reports that a large portion of the group stayed and enjoyed themselves until the final strains were played at 1:00 a. m.

Pittsburgh Continues Symposium on Air Conditioning an Office Building

February 8, 1937. Pres. M. L. Carr called the meeting of Pittsburgh Chapter to order in the Downtown Y.M.C.A. and the minutes of the January meeting were read and approved. Forty-eight members and guests attended.

Treas. J. E. McLean reported that $40.00 of 1937 dues had been received.

P. A. Edwards of the Membership Committee told of the application of two new members.

Chairman J. F. Collins, Jr., Program Committee, stated that one more meeting would be devoted to the problem of air conditioning an office building.

President Carr, Chapter delegate to the 43rd Annual Meeting of the Society, January 25-27, read a complete report covering his activities in St. Louis, Mo.

In the absence of Prof. C. M. Humphreys, Secy. T. F. Rockwell reviewed the items of Council action which concerned the Pittsburgh Chapter.

It was moved by T. M. Dugan, seconded by R. A. Miller and carried, that R. J. J. Tennant be authorized to investigate the problem of securing a sponsor for broadcasting, in the public interest, a series of educational talks on heating, ventilating and air conditioning over a local station; all programs subject to the approval of the Society's Council.

President Carr turned the meeting over to Mr. Tennant who again presided at the Symposium on Air Conditioning an Office Building. Mr. Tennant first reviewed the nature of the problem and its limitations, and then introduced the following speakers in turn: H. A. Cannon, who completed his analysis of the space requirements and the design of the duct system; F. C. McIntosh, who explained the proposed method for automatic control of temperature and outdoor air supply during the cooling season; Leighton Orr, who explained the savings in heat gain that might accrue because of the use of heat absorbing glass or

of double glazing; M. W. Lightcap, who discussed the effects of interior painting and lighting on the cooling load in air conditioned buildings.

A considerable amount of animated discussion from the audience followed each paper, and the meeting adjourned at 10:50 p. m.

Air Conditioning and Pipe Welding Discussed by Massachusetts Chapter

January 19, 1937. Massachusetts Chapter held a dinner meeting at Walker Memorial, Massachusetts Institute of Technology and Secy. John Turner reported that approximately 70 members and guests were present at the meeting. The material increase in the attendance of members and guests is gratifying to Chapter officers and it is believed due to the fact that the subjects selected for presentation and discussion have had a wide appeal.

Owing to the inability of V. S. Day to be present, the subject of Air Conditioning Homes was presented by Mr. Carlson, Carrier Corp., Newark, N. J. Mr. Carlson delivered an interesting lecture showing various systems of control for air conditioning of private residences, which was followed by a general discussion.

The second speaker of the evening was L. F. Jackson, of The Linde Air Products Co., who showed a series of interesting moving pictures describing methods of pipe welding in heating systems, industrial applications, and gas pipe line installations.

Corrosion Studies Topic of Philadelphia Chapter Meeting

February 11, 1937. The regular meeting of Philadelphia Chapter was held at the Engineers Club with Pres. W. F. Smith presiding. The minutes of the previous meeting and the report of the treasurer were read and approved.

A report was offered by the Membership Committee through its chairman, A. E. Kriebel.

The Year Book Committee told of the publication of the current year book which netted a profit of $60.60.

R. C. Bolsinger, member of the Society's Council, reported on the 43rd Annual Meeting of the A.S.H.V.E. held in St. Louis, Mo., January 25-27, and gave a complete and interesting resumé of the various events on the program. He also announced his appointment as chairman of the Membership Committee of the Society and told of his plans for the coming year.

C. B. Eastman, chairman of the Meetings Committee, spoke of plans for the next meeting and H. H. Mather then introduced the speaker of the evening, A. E. Stacey, Jr., New York, N. Y., whose paper on Studies Made on Corrosion proved to be of interest.

L. P. Hynes thanked Mr. Stacey on behalf of the Chapter for his able presentation, and Secy. H. H. Erickson reports that the meeting then adjourned at 9:30 p. m.

F. C. Houghten Speaker at Kansas City Meeting

January 29, 1937. When the Kansas City Chapter met at the Newbern Hotel, 31 members were present for dinner and 4 additional members were able to arrive in time to hear the speaker. Pres. L. R. Chase presided and opened the meeting by introducing the guests of the evening.

J. H. Kitchen ably expressed the Chapter's appreciation for the services rendered it by W. A. Russell who has recently been transferred by his company to Detroit, Mich. The motion was offered and unanimously carried that Mr. Russell be elected an honorary member of the Kansas City Chapter of the A.S.H.V.E.

Mr. Russell gave a brief outline of the 43rd Annual Meeting of the Society held in St. Louis, Mo., January 25-27, for the benefit of those who were unable to attend.

The speaker of the evening was F. C. Houghten, director of the A.S.H.V.E. Research Laboratory, Pittsburgh, Pa. In an interesting manner Mr. Houghten presented the subject of Cooling Requirements for Summer Comfort Air Conditioning. He first outlined the history of research on this subject which has covered a period dating back to 1919. It was pointed out that since that time many of the old theories have been revised and that even today additional information is needed to complete the study. Charts and tables were shown which clearly described the complications and many angles of the subject presented.

After Mr. Houghten's formal presentation, the Chapter members participated in a general discussion of the topic, according to the report of Secy. F. J. Dean, Jr.

Ontario Chapter Hears Talk on Hot Water Heating Systems

February 1, 1937. Seventy-two members and guests attended the regular February meeting of Ontario Chapter at the Royal York Hotel, Toronto.

Following dinner, Pres. Thomas McDonald made a few announcements and called upon J. W. O'Neill, who spoke of the Society's 43rd Annual Meeting in St. Louis, Mo., January 25-27.

E. R. Gauley introduced the principal speaker of the evening, S. A. Armstrong, who gave an illustrated talk on Forced Circulation Hot Water Heating Systems.

Mr. Armstrong's address was instructive and was followed by an interesting discussion.

A vote of thanks was extended to the speaker on behalf of the Chapter by H. S. Moore before the meeting adjourned.

Residence Air Conditioning Research Reviewed at Montreal Chapter Meeting

January 11, 1937. Following dinner, Pres. G. L. Wiggs called to order the meeting of Montreal Chapter held at the Windsor Hotel, with 44 members and guests attending.

Following roll call and the introduction of guests, the minutes of the previous meeting were read by Secy. C. W. Johnson and approved.

President Wiggs introduced the principal speaker of the evening, John James, technical assistant, American Society of Heating and Ventilating Engineers. Mr. James' subject was A Review of Residence Air Conditioning Research and at the conclusion of his talk a general discussion was held. A vote of thanks was extended to the speaker on behalf of the Chapter by Mr. Dixon.

Telegrams were read from the St. Louis Chapter and from Pres. G. L. Larson, extending invitations to Montreal members to attend the Society's Annual Meeting at St. Louis, Mo., January 25-27.

A discussion was held relative to changing the date of the Chapter meeting, resulting in the decision to hold the next few meetings on the third Monday in each month and to continue with this date if it is found satisfactory to the majority of members.

The question of inviting the A. S. H. V. E. to meet in Montreal in the summer of 1938 was considered and unanimously approved.

Mr. McKerlie on behalf of the *Canadian Refrigeration and Air Conditioning Association* extended an invitation to all Chapter members to attend their meeting, January 18, at which time J. H. Fox, Minneapolis-Honeywell Regulator Co., Ltd., Toronto, would deliver a paper on Automatic Control of Refrigerating and Air Conditioning Systems.

The meeting adjourned at 9:30 p. m.

J. H. Walker Is Speaker at Michigan Meeting

January 18, 1937. The members of Michigan Chapter were guests of the Detroit Edison Co. for their regular January meeting when about 130 responded to Pres. R. K. Milward's call to order at 7:30 p. m. and W. G. Boales introduced 40 A. S. H. V. E. members who have affiliated with Michigan Chapter since October, 1936. G. D. Winans announced the annual dinner dance scheduled for February 8 at Dearborn Inn.

J. H. Walker, superintendent of central heating and engineering assistant to the general manager of Detroit Edison Co., was introduced by Mr. Winans as the speaker of the evening.

The subject of Mr. Walker's talk was A Discussion of Some of the Engineering Problems in the Construction of a Windowless Building. Mr. Walker stated that the decision to construct a windowless building was made largely upon the factor of increasing comfort and that some of the problems encountered in designing this type of building are: caring for the expansion of the glass brick, lighting, ventilating, air conditioning, and accurate temperature control.

After Mr. Walker's talk, the movie Earthworm Tractor was shown. The meeting adjourned at 10:30 p. m. according to the report of Secy. G. H. Tuttle.

Research Laboratory Paper Discussed by St. Louis Chapter

December 9, 1936. Pres. C. R. Davis presided at the meeting of St. Louis Chapter held at the David Ranken Trade School which was attended by 12 members and 21 guests.

Minutes of the November meeting were read and approved and President Davis announced that he would call on some of the chairmen of the Committee on Arrangements for the Society's 43rd Annual Meeting to outline their activities.

Secy. R. J. Tenkonohy reported on the election and reinstatement of several members and Treas. C. E. Hartwein reported a balance of $350.63.

In speaking for the Educational Committee, G. B. Rodenheiser said that the David Ranken Trade School had just added considerable material to its air conditioning laboratory and invited all present to inspect the equipment and offer their comments.

Mr. Rodenheiser presented Mr. Martin, recently appointed superintendent of the school, who outlined the objectives of David Ranken Trade School. Mr. Martin asked the Chapter, as representative of the industry, several questions, including, what should the tradesman know; what should be his aim; what type of boy should be selected; what should the school's equipment be. President Davis informed Mr. Martin that a committee would confer with him on the matters of interest.

J. W. Cooper reported for the Membership Committee that an application had been received from R. C. Driemeyer and introduced the candidate to the Chapter.

General plans for the Annual Meeting of the Society in St. Louis, Mo., January 25-27, were outlined by President Davis, general chairman of the Committee on Arrangements and by the following committee chairmen: J. W. Cooper, P. W. Sodemann, G. W. Myers and D. J. Fagin.

A recess was called and when the meeting reconvened in the Ranken gymnasium, the Chapter and its guests were joined by a portion of the school's air conditioning classes and 125 were present. President Davis again outlined Annual Meeting plans and urged all to attend the technical sessions and the entertainment functions, and then turned the meeting over to Mr. Fagin.

Mr. Fagin introduced G. B. Rodenheiser and P. W. Sodemann, who read and commented on the paper, Cooling Requirements for Summer Air Conditioning, which was prepared by the A. S. H. V. E. Research Laboratory.

Mr. Greve was next presented by Mr. Fagin and showed an interesting talking moving picture entitled, The Machine Mining of Coal.

President Davis then adjourned the meeting at 10:15 p. m.

S. S. Clarke

It is with regret that the death is recorded of Samuel S. Clarke on February 1, 1937, at Calgary, Alta., Can., for Mr. Clarke was elected a Member of the A. S. H. V. E. in 1909 and was honored by action of the Council conferring Life Membership in 1933.

Tribute has been paid to Mr. Clarke by an old friend and former business associate, who says: "His death brought to a close a 60-year association with the plumbing, heating and ventilating industry in Canada, and left to a wide acquaintance a memory of a courteous, kindly and even tempered gentleman, and of a sound and skilled designing and consulting engineer. In truth, it can be said that growing up with the expansion of the plumbing and heating business in the past half century in Canada, he was one of the leaders for good workmanship, sound trade practices, and the intelligent use of the many developments that this long period has brought forward. In the province of Alberta in Canada where he had lived for the last 30 years in its period of growth, he exercised a great influence and was regarded as the authority on heating and ventilating problems."

Mr. Clarke was born in Birmingham, England, December 18, 1863, and came to Canada in 1876. He attended English ordinary and high schools and The School of Practical Science at Toronto. He entered the office of Bennett & Wright Co., Ltd., Toronto, in 1881 and remained with the company until 1907 when he joined the Dominion Radiator Co. and moved to Calgary in charge of its Alberta district. Here he resided until his death. In his later years he formed the firm of S. S. Clarke & Company, Ltd., representing Darling Brothers, Ltd., Canadian Sirocco Co., Ltd., Johnson Temperature Regulating Co., Ltd., Tuttle & Bailey Mfg. Co., and the Iron Fireman Manufacturing Co., Ltd.

Mr. Clarke is survived by his widow, one daughter, three sons, and eight grandchildren, to whom the Officers and Council have extended their sincere sympathy.

Arthur K. Ohmes

Arthur K. Ohmes, consulting engineer, died February 11, 1937, at his home, 260 Washington Place, Hasbrouck Heights, N. J. He was 62 years old and had been ill only a short time of pneumonia.

Mr. Ohmes, who was a leader in the field of heating and ventilating, was born in Goslar, Germany, and studied engineering in his native land under private instructors.

During the period after his arrival in the United States in 1894 he served as consulting engineer and designer of mechanical equipment for many large buildings in New York, other parts of the U. S. and abroad. He designed the heating and ventilating equipment for Bellevue Hospital, Hotel Pennsylvania, Metropolitan Museum of Art, and the Museum of Natural History in New York City, and also the mechanical equipment for buildings in Tokyo, Havana and Montreal. He was treasurer of Tenney & Ohmes, Inc., consulting engineers, with offices at 101 Park Ave., New York, N. Y.

During his early days in this country Mr. Ohmes lectured at Columbia University on mechanical engineering. He also was the author of textbooks and articles on the subject.

Mr. Ohmes joined the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in 1913 and served as a member of the Council in 1915, as second vice-president in 1916, and as first vice-president in 1917. He was a member of the *American Society of Mechanical Engineers,* the Engineers Club of New York, and was on the Board of Consulting and Contributing Editors of *Heating, Piping and Air Conditioning.*

It is with regret that the Officers and Council of the A. S. H. V. E. learn of the death of their former associate and member.

Mr. Ohmes is survived by his widow, a daughter, two sons, three sisters, and a brother.

Mathieu L. Sakouta

Word has just reached headquarters office from Leningrad, U. S. S. R., of the death of Mathieu L. Sakouta on December 11, 1936.

Mr. Sakouta was the first member of the A. S. H. V. E. in U. S. S. R., having been elected in 1924.

Since 1906 Mr. Sakouta had served as a consulting engineer and he was identified with the design and construction of many of the largest buildings in U. S. S. R. and was proud of the publication of many papers in the technical press during the past 30 years.

Born at Bilaystok, Poland, on March 4, 1872, he attended the Polytechnische Hochschule in Riga for 5½ years and received a diploma as a mechanical engineer. He also took a post graduate course at Berlin Polytechnic. From 1900-1903 he was with the Union Electric Co., Riga, as constructor of electric apparatus and from 1903-1906 he was with S. Timachovitz, Moscow, in charge of the heating and ventilating department and studying European ventilating systems.

Since 1906 he had been a consulting engineer operating his own office, specializing in heating and ventilating and was associated with the government at Petrograd.

The Officers and Council members regret the passing of Mr. Sakouta and express their sympathy to his family who survive.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 41 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by March 15, 1937, these candidates will be ballotted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ANNAS, H. C., Sales Engr., R. L. Spitzley Htg. Co., Detroit, Mich.	W. F. Arnoldy R. L. Spitzley	J. R. Bergan H. H. Hill
BAKER, H. S., Sales Engr., Bakersfield Hardware Co., Bakersfield, Calif.	Albert Buenger Leo Hungerford	O. W. Ott A. R. MacMillan
BATES, H. C., Chief of Fibre Prod. Lab., Corning Glass Works, Corning, N. Y.	B. C. Davis Games Slayter	D. C. Simpson W. M. Sawdon
BELDING, H. H., Chief Engr., Gathright, Inc., Richmond, Va.	O. J. Prentice C. E. Price	C. A. Thinn H. L. Pelouze, II
BLEDSOE, R. P., Engr., The Trane Co., La Crosse, Wis.	R. H. Anderegg W. A. Rowe	M. W. Miller William Goodman (*Non-Member*)
BOTELHO, N. J., Engr. & Mgr., Ceibrasil Representacoes, Ltda., Rio de Janeiro, S. A.	M. H. Darby A. E. Stacey, Jr.	M. S. Smith R. T. Thornton (*Non-Member*)
BRATT, H. D., Individual Ownership, Temperature Control Systems, Grand Rapids, Mich.	W. W. Bradfield C. H. Morton	P. O. Wierenga O. D. Marshall
CALVER, R. W., Plbg. & Htg. Contractor, R. W. Calver, Kirkland Lake, Ont., Can.	J. A. M. Robertson G. L. Wiggs	W. U. Hughes J. A. Morris
CAMPBELL, R. L., Sales Engr., Airtemp, Inc., Minneapolis, Minn.	A. B. Algren R. A. Gonzalez	Frederic Bass (*Non-Member*) A. S. Cutler (*Non-Member*)
COMB, F. R. JR., Student, University of Minnesota, Minneapolis, Minn.	F. B. Rowley A. B. Algren	C. E. Lund B. J. Robertson (*Non-Member*)
DEVORE, A. B., Htg. Engr., James A. Messer Co., Inc., Washington, D. C.	W. F. Goddard W. E. Kingswell	P. B. Holmes G. F. Miller
DION, A. M., Air Cond. Engr., Sheldons, Ltd., Galt, Ont., Can.	W. C. Oke W. R. Blackhall	G. A. Playfair J. W. O'Neill
DOXEY, H. E., Engr., Metropolitan Bank Bldg. Co., Minneapolis, Minn.	F. B. Rowley A. B. Algren	C. E. Lund B. J. Robertson (*Non-Member*)
FIFE, G. D., Air Cond. Engr. for Archt. of the Capitol, Washington, D. C. (*Advancement*).	C. S. Pabst A. C. Buensod	H. A. Thornburg William Goulding
FINNERTY, J. A., Sales Engr., Herman Nelson Corp., New York, N. Y.	R. H. Nelson E. R. Walsh, Jr.	F. G. Freitag G. E. Otis
FULLER, H. T., Student, Pratt Inst., Brooklyn, N. Y.	J. W. Hunter (*Non-Member*) C. C. Carr (*Non-Member*)	E. A. Hertzler (*Non-Member*) R. S. Ferris (*Non-Member*)
GRIESS, P. G., Mech. Engr., Voorhees, Gmelin & Walker, New York, N. Y.	W. E. Heibel D. J. Purinton	C. W. A. Steinmetz W. M. Heebner
GROSSMAN, F. A., Student, Purdue Univ., West Lafayette, Ind.	J. D. Hoffman W. T. Miller (*Non-Member*)	H. G. Venemann (*A. S. R. E.*) G. A. Young (*Non-Member*)

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
HOWARD, F. L., Chief Engr., Refrigeration & Air Cond. Inst., Chicago, Ill.	A. G. Sutcliffe Tom Brown	F. P. Keeney C. E. Price
JENNINGS, R. A., Chief Engr., Keith Mass. Corp., Boston, Mass.	I. E. Shaer John Turner	G. P. Dickson W. P. Buchanan (*Non-Member*)
KEATING, A. J., Design Engr., Cooling & Air Cond. Corp., Chicago, Ill.	A. C. Bartlett J. F. G. Miller	H. C. Mueller E. W. Rietz
KERR, W. E., Engr. & Sales Repr., W. E. Kerr, Columbia, S. C.	W. E. Barnes W. T. Jones	George Lafaye (*Non-Member*) R. W. Mitcham (*Non-Member*)
KOTZEBUE, R. W., Air Cond. Engr., Straus-Frank Co., San Antonio, Texas.	C. E. Lewis A. R. MacMillan	Albert Buenger J. R. Straus (*Non-Member*)
LEUTHESSER, F. W., Jr., Vice Pres., National Metal Products Corp., Chicago, Ill.	C. M. Baumgardner C. E. Price	E. F. Glore C. C. Hansen
MARTEL, C. L., Engr., Bryant Air Cond. Corp., Detroit, Mich.	R. K. Milward R. F. Connell	W. G. Boales G. D. Winans
MARTIN, RAYMOND, Sales Mgr. (Heat Dept.) Vapor Car Htg. Co. of Can., Ltd., Montreal, Que., Can.	G. H. Osborne G. L. Wiggs	C. W. Johnson J. A. Morris
NESSELL, C. W., Field Application Engr., Minneapolis-Honeywell Reg. Co., Dayton, Ohio.	F. A. Rodgers R. A. Wilson	G. W. Kingsland K. W. Schick
O'FLAHERTY, J. G., Ch. Engr., Canada Vulcanizer & Equip. Co., Ltd., London, Ont., Can.	A. S. Leitch M. S. Woollard	H. H. Angus H. R. Roth
RODGERS, F. E., Plbg. & Htg. Engr., Rodgers Plbg. & Elec. Sup. Co., McKees Rocks, Pa.	C. M. Humphreys T. F. Rockwell	P. A. Edwards F. C. Houghten
RONSICK, E. H., Industrial Gas Engr., The St. Louis County Gas Co., Webster Groves, Mo.	C. E. Hartwein G. W. F. Myers	D. J. Fagin C. R. Davis
RUDD, D. J., Mech. Designer, N. Y. Worlds Fair 1939, Inc., New York, N. Y.	T. W. Reynolds S. R. Apt	A. L. Hinrichsen H. W. Fiedler
SAHLMANN, F. L., Transp. Dept., General Electric Co., Erie, Pa.	F. H. Faust D. W. McLenegan	Elliott Harrington A. R. Stevenson, Jr. (*Non-Member*)
SCHAD, C. A., Draftsman, U. S. Air Cond. Corp., Minneapolis, Minn.	F. B. Rowley A. B. Algren	C. E. Lund B. J. Robertson (*Non-Member*)
SIMISON, A. L., Research Engr., Owens-Illinois Glass Co., Newark, Ohio.	Games Slayter D. C. Simpson	F. L. Myers F. C. Houghten
SIMPSON, W. M., Student, Clemson College, Clemson, S. C.	D. H. Shenk A. B. Credle (*A. I. E. E.*)	B. S. Fernow (*A. S. M. E.*) F. T. Tingley (*A. I. E. E.*)
SMITH, D. K., Engr. & Estimator, H. F. Wangler, Philadelphia, Pa.	J. M. Traugott A. G. Dome	J. H. Hucker P. S. Pryibil
STEWART, W. O., Engr., R. L. Spitzley Htg. Co., Detroit, Mich.	J. R. Bergan G. D. Winans	W. F. Arnoldy L. J. Morrow (*Non-Member*)
VOIGT, R. N., Student, Purdue University, West Lafayette, Ind.	J. D. Hoffman A. A. Potter (*A. S. M. E.*)	W. T. Miller (*A. S. M. E.*) G. A. Young (*A. S. M. E.*)
WALZ, G. R., Field Engr., Minneapolis-Honeywell Reg. Co., Washington, D. C.	G. B. Supple H. F. Dever	G. D. Kingsland J. E. Haines (*Non-Member*)
WEINERT, F. C., Sales Engr., Chamberlin Metal Weather Strip Co., Detroit, Mich.	D. S. Knapp F. W. Morse, Jr.	H. L. Hosking R. S. Bruns, Jr. (*Non-Member*)
WOODS, B. M., Prof. Mech. Engrg., University of California, Berkeley, Calif.	O. W. Ott J. F. Park	Harrold English E. H. Kendall

Candidates Elected

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

CASE, D. V., Mgr., B. D. R. Materials, Inc., Kansas City, Mo.

CLINE, E. A., Sales Engr., Air Cond. Co., Los Angeles, Calif.

GAMBLE, C. L., Capt., U. S. Army, Ft. Leavenworth, Kansas.

HUGHSON, H. H., Sales Engr., The Coon-DeVisser Co., Detroit, Mich. (*Reinstatement*).

MERCER, C. F., Prof. of Physics, Univ. of South Carolina, Columbia, S. C.

PATTON, R. L., Pres., Roy L. Patton, Inc., Oklahoma City, Okla. (*Reinstatement*).

REAMER, W. S., Jr., Vice Pres., Reamer Industries, Inc., Columbia, S. C.

SCHMIDT, HARRY, Air Cond. Engr., Fedders Mfg. Co., Buffalo, N. Y.

WAGNER, E. A., Pres., Wagner Engrg. Corp., Pittsfield, Mass. (*Advancement*).

ASSOCIATES

FOLEY, D. F., Sales, W. B. Young Supply Co., Kansas City, Mo.

SINGLETON, J. H., Sales Engr., R. L Spitzley Htg. Co., Detroit, Mich.

WEEKS, PAUL, Mgr., Engine Sales Div., Caterpillar Tractor Co., Peoria, Ill.

WEIDELE, E. J., Air Cond. Sales Engr., General Electric Air Cond. Co., Los Angeles, Calif.

JUNIORS

CAMPBELL, G. S., Air Cond. Engr., Tenn. Elec. Power Co., Nashville, Tenn.

DE SOMMA, A. E., Jr. Engr., L. J. Wing Mfg. Co., New York, N. Y.

MEYER, JOSEPH, JR., Sales Engr., Edwin Sterner Co., Flint, Mich.

PALMASON, J. H., Assessor, City of Winnipeg, Winnipeg, Man., Can.

WADSWORTH, R. H., Air Cond. Engr., Clarage Fan Co., Kalamazoo, Mich.

LEAK-PROOF THAT means LEAK-PROOF

BUY ACCO QUALITY

A FEW OF THE 137 AMERICAN CHAIN & CABLE INDUSTRIAL PRODUCTS

AMERICAN CHAIN DIVISION
(DOMINION CHAIN COMPANY, Ltd., in Canada)
Weed Tire Chains • Welded and Weldless Chain • Malleable Castings • Railroad Specialties

AMERICAN CABLE DIVISION
Tru-Lay Preformed Wire Rope • Tru-Loc Processed Fittings • Crescent Brand Wire Rope Tru-Stop Brakes

ANDREW C. CAMPBELL DIVISION
Abrasive Cutting Machines • Floformers Special Machinery • Nibbling Machines

FORD CHAIN BLOCK DIVISION
Chain Hoists • Trolleys

HAZARD WIRE ROPE DIVISION
Green Strand Wire Rope • "Korodless" Wire Rope • Preformed Spring-Lay Wire Rope • Guard Rail Cable

HIGHLAND IRON & STEEL DIVISION
Wrought Iron Bars and Shapes

MANLEY MANUFACTURING DIVISION
Automotive Service Station Equipment

OWEN SILENT SPRING COMPANY, Inc.
Owen Cushion and Mattress Spring Centers

PAGE STEEL AND WIRE DIVISION
Page Fence • Wire and Rod Products Traffic Tape • Welding Wire

READING-PRATT & CADY DIVISION
Valves • Electric Steel Fittings

READING STEEL CASTING DIVISION
Electric Steel Castings, Rough or Machined

WRIGHT MANUFACTURING DIVISION
Chain Hoists • Electric Hoists and Cranes

Lubrotite GATE VALVES

● Here is a valve that remains tight regardless of service conditions. The seating surfaces are protected and even if the protection is penetrated, the effects of the damage are offset.

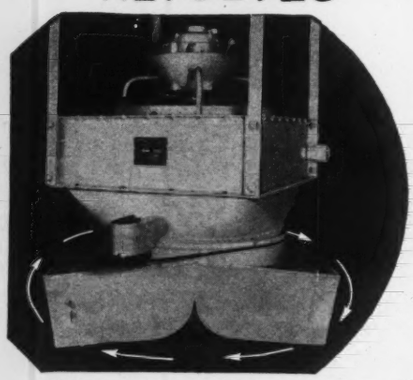
By a unique duct system, a *lubricant-seal* is applied between the seating surfaces of the Lubrotite Valve. This lubricant seal reduces friction and wear to a minimum and coats the seating surfaces with a corrosion resistant film. Though seating surfaces may become worn and scratched to an extent that would produce increasing leakage in ordinary valves, the lubricant seal fills in the damage and keeps the valve absolutely tight.

You find a definite relief from leaks, and therefore less necessity for servicing when you use Lubrotite Gate Valves—just as with other Reading-Pratt & Cady Valves.

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE COMPANY, Inc.
BRIDGEPORT, CONNECTICUT
In Business for Your Safety

READING·PRATT & CADY VALVES

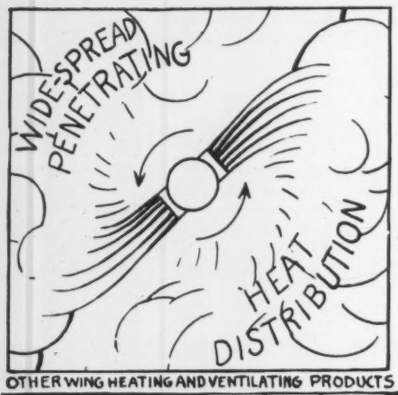
And now a unit heater with a DISCHARGE THAT REVOLVES



It's the last word in thorough and economical heat penetration and spread—an entirely new principle—eliminates hot and cold spots. The slowly revolving discharge projects comfortably warm air to the walls and remote corners,—and around obstructions.

Write for Bulletin W-227 TODAY!

L. J. WING MFG. CO.
W. 14th St. & 7th Ave., New York, N. Y.



OTHER WING HEATING AND VENTILATING PRODUCTS

What are your needs? send for full details today

WING
Featherweight All direction
UNIT HEATER

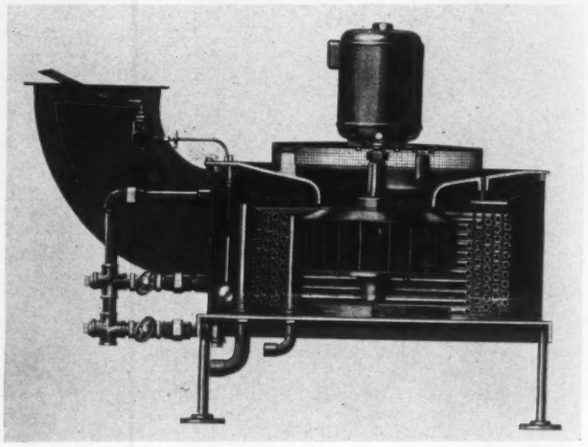
Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 166. Add the new products and companies listed here to your Directory Section which you received in your January, 1937, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

Evaporative Condensers of New Design

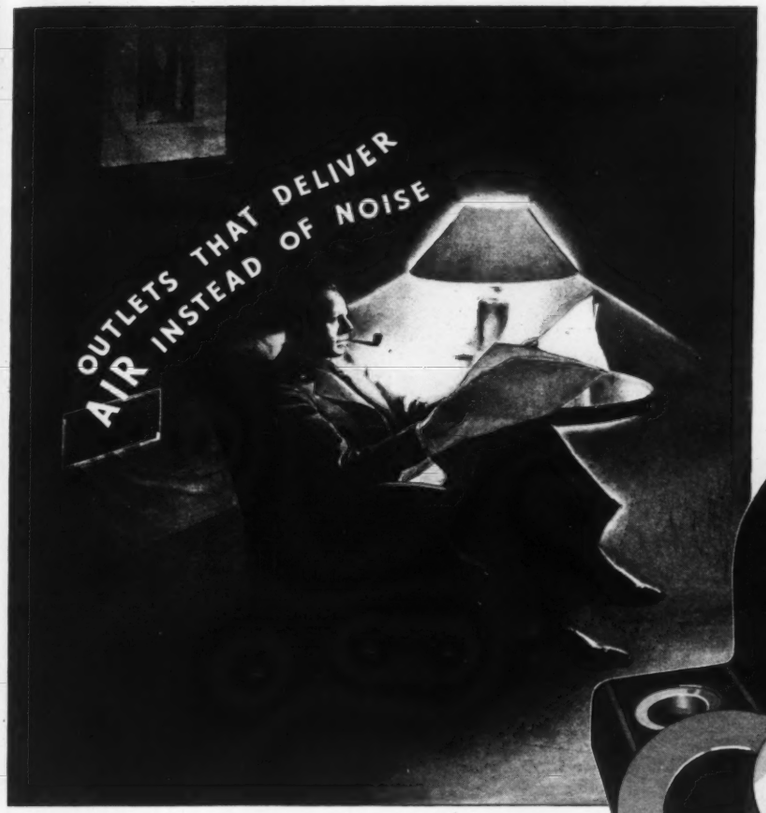
No. 1177*—New "GR Hydrocyclonic" evaporative condenser comes in three sizes at the present time, and is designed for use on methyl chloride and "Freon-12" installations. The three sizes are for compressors ranging from 15,000-45,000; 30,000-90,000; and 40,000-120,000 Btu per hr capacity.

The unit is self-contained, and includes a complete assembly of tank, condenser coil, motor fan, water lift, float control and water valves. The circular tank has a side outlet ell for air discharge from the condenser coil. The ell is flanged for connection to a discharge duct and a self-acting damper prevents outside air from entering the condenser body through the ell when the equipment is not in operation. The condenser coil, consisting of a series of flat pancake coil sections, is installed in the tank and connected to a refrigerant inlet header on the outside of the coil and a liquid outlet header on the inside end of the coil. Each coil section slopes downward, permitting the condensed refrigerant to drain from the tubes into the liquid outlet header. A vertical rubber-mounted totally enclosed motor (¼, ½ or ¾ hp) is supported over the air inlet tunnel forming the top of the tank. A special fan (800, 1600 or 2400 cfm) with a conical water lift hub is directly attached to the bottom of the motor shaft extension.



Operating economy is an outstanding feature, and the balanced performance to meet varying air and water conditions results in a saving of as much as 95 per cent of the usual water cost, according to the manufacturer. Water, propelled by centrifugal force, is mixed with the air traveling at "cyclone" speed, and the resultant spray goes over the hot refrigerant coils. This transforms the heat from the coil to the evaporating water, which is carried off in the air. The water is completely evaporated. A float valve automatically maintains proper water level in the tank.

It is not necessary to remove the coils to clean them. They may be completely submerged and flushed clean. There are no nozzles to clog, as water is forced into a spray by means of a motor driven conical water lift. Only one motor is used to operate the water lift and vertical blower fan. No pump is re-



For QUIET *Fan Operation*

SIZES OFFERED
Fafnir Rubber Pillow Blocks are provided in sizes from 11/16 to 1-3/16 inches bore.

Fafnir RUBBER Pillow Blocks

- Silent
- Friction-Free
- Long Wearing
- Economical
- Compact
- Easily Mounted

Already adopted as standard equipment by several leading manufacturers. For complete details, write for Bulletin "R". The Fafnir Bearing Company, New Britain, Conn.

A time-tested, time-proved single row radial ball bearing BUT, pressed into a housing of long-life molded rubber to produce an effective and exclusive new Fafnir unit.

It is silent—internal noise is completely absorbed. The design of the bearing gives it ample capacity for all normal loads, and Fafnir's high manufacturing standards assure you that it is friction-free. The resiliency of the rubber mounting compensates for misalignment or slight longitudinal shaft expansion. The bearing is packed with sufficient grease to last for years. Dirt is sealed out by integral plate shields.

The rubber housing permits manufacturing economies that bring the price of these units to a level comparable with conventional plain bearings.

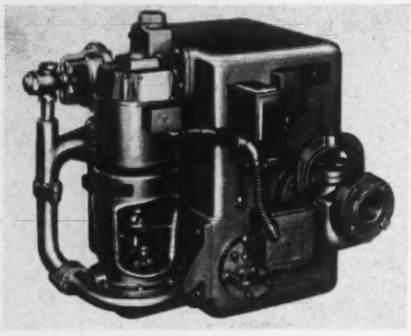
FAFNIR BALL BEARINGS

THE MOST COMPLETE RANGE OF TYPES AND SIZES IN AMERICA

quired. The entire unit is compact, the dimensions of the largest of the three sizes being 67¾ in. long, 43 in. wide, and 46¼ in. high.—General Refrigeration Sales Co., Shirland Ave., Beloit, Wis.

Vertical Vacuum Pumps of Improved Design

No. 1178—New "Hoffman-Economy V-V" vertical vacuum pump is offered in four sizes with capacities from 250 to 15,000 sq ft of radiation. According to the manufacturer, the design was developed to answer modern demand for elimination of excess bulk and weight, and economy.



Like all "Hoffman-Economy" pumps, the "V-V" type has a jet vacuum producer with no moving parts. A number of features are included, which are listed in the manufacturer's announcement as follows:

Pump—Bronze fitted throughout; centrifugal pump, fitted with enclosed type, non-overloading, carefully machined impeller; stainless steel shaft accurately turned and ground; split bronze packing gland; shielded deep groove ball bearing carries pump shaft independent of motor bearings; renewable bronze wearing rings; heavy flexible couplings; motor support bored simultaneously with bearing seats to assure alignment of pump and motor; oil-less renewable bearing.

Motor—Continuous rated 40 C ball bearing motor mounted high above floor so as to be protected from dirt and water.

Receiver—Cast iron double chamber receiver; lower chamber is the accumulator tank; upper chamber holds circulating water and acts as separator chamber for air and water: low inlet eliminates need for pit except in rare instances; self cleaning, externally mounted strainer.

Control—Complete automatic float and vacuum control with overload protection; magnetic starters furnished on units 1½ hp and larger; float switch operated by seamless copper float on rocker shaft with spring adjusted packing gland; diaphragm operated boiler feed valve of single seated type controlled by float operated, non-sticking, pilot valve with stainless steel stem and seat.

It is stated that because of the type of construction employing the jet vacuum producer that the pump is able to deliver full rated capacity in water close to the boiling point, and that the unit readily handles peak air or water conditions as they may occur in the system—Hoffman Specialty Co., Inc., Waterbury Natl. Bank Bldg., Waterbury, Conn.

Electrostatic Precipitator for Industrial Air Cleaning

No. 1179—A new electrostatic precipitator for general industrial air cleaning use with an operating efficiency as high as 99 per cent by weight is particularly suitable for salvaging valuable dust, mass air cleaning, or removing objectionable particles from gas or vapor, and similar applications, according to the maker, who lists the following advantages:

Small size of unit reduces space requirements and cost and permits a complete factory assembled unit.

Small vacuum tube power pack attached directly to precipitator cabinet eliminates separate room for high voltage generating equipment.

Discharged air does not contain appreciable amounts of ozone nor oxides of nitrogen and may be breathed without irritation of the membranes.

May be designed for efficiencies as high as 99 per cent (by weight) and to remove particles as small as 1/5 micron.

Operates at low voltages permitting use of electronic tubes of standard industrial classification and with low power consumption.

Low and constant air flow resistance through the unit results in reduced power and uniform air volume.

REX-WELD "Super-Service"
VIBRATION ABSORBERS
for Air-Conditioning Machinery
● Here's the ideal solution to the compressor noise problem! Installed in the suction and discharge lines, these Rex-Weld Flexible Metal Tubing Units effectively dampen the vibration and put an end to the annoying hammering—surely, safely and economically . . . Produced by an exclusive patented process which forms the flexible tubing corrugations without weakening the special, non-porous, non-crystallizing bronze alloy. Supplied complete with capped ends ready for sweating onto standard water tubing. Write for Bulletin RW-4 and Data Sheet. Send us your specifications for prices.
CHICAGO METAL HOSE CORPORATION
(Formerly Chicago Tubing and Braiding Company—Est. 1902)
Maywood, Illinois (Chicago Suburb)

"... a very welcome service ... constructive ... fills a real need ... timely ... helpful in judging developments ... authoritative ... full of vital information ... extremely useful ... a great service ..."

★ ★ ★ **AIR CONDITIONING** ★ ★ ★

Issued From "AIR CONDITIONING HEADQUARTERS"

TRENDS

JANUARY 1937

Keeney Publishing Co., Publishers of "Heating, Piping & Air Conditioning" and "American Artisan" • 6 No. Michigan Ave., Chicago

NEW SERVICE WELL RECEIVED

Pleased were air conditioning sales, advertising, and administrative executives with the first issue of **Air Conditioning Trends,** the new monthly news bulletin devoted to the sales and merchandising aspects of the air conditioning business. Excerpts from a few of their hundreds of letters commenting on the initial number are shown on this page.

A contribution to the better selling and promotion of air conditioning, **Trends** each month will collect and publish 1) reliable facts and figures on the various air conditioning markets, 2) information showing why, when, and how these markets can be sold, and 3) other practical data that will assist those responsible for the SALE of air conditioning to correctly interpret new developments and meet current selling problems.

Each issue will be devoted to a specific subject of current interest to the seller. Thus, the inaugural January number dealt with public utilities and their place in the upbuilding of air conditioning, while the February issue furnishes a comprehensive survey of the hotel market for air conditioning.

WILL HELP DEVELOP NEW BUSINESS

Whenever occasions for so doing present themselves, Trends will lend its assistance in actually developing business in specific markets. Thus its February "Hotel" issue, which contains numerous data proving that hotel guest room and dining room air conditioning is a profitable investment, has been sent to 922 large hotels considered the best immediate prospects for air conditioning.

"I have looked over the first issue of **Air Conditioning Trends.** This I believe, is a very desirable publication to all who are interested commercially in the air conditioning field. . . ."
W. H. Carrier, Chairman of the Board Carrier Corp.

". . . . first issue was of considerable interest. There is a very definite place for a publication of this type in our industry."
A. B. Schallenberg, Alco Valve Co.

"Your first issue of **Trends** . . . . strikes me as a sound, helpful sales bulletin."
T. R. Crawford, Media Dept., M. Glenn Miller, Advertising

". . . . We have already received some helpful suggestions from the bulletin which will assist us in the promotion of air conditioning."
Clem R. Winkler, General Sales Mgr., West Tennessee Power & Light Co.

"I found the first number very interesting . . . am following developments in the air conditioning field with close interest."
Lyman Thompson, N. W. Ayer & Son, Inc.

"I have just seen the first copy . . . and believe you are starting right out to pack it full of vital information."
K. W. Cash, Adv. Mgr., Penn Elec. Switch Co.

". . . Undoubtedly—**Trends** will be a very valuable asset as it develops, and you are to be commended for publishing and distributing such a fine paper."
H. H. Wulf, Sales Eng., In Charge of Comm'l Air Cond., Kelvinator Corp.

". . . **Trends** strikes us as one of the most authoritative and up-to-date references that has come to our attention. . . ."
Robert A. Campbell, Vice-President, Scott Valve Mfg. Co.

". . . first copy very interesting. We really believe a publication of this kind has a place and fills a real need in the industry due to the point of view from which it is written."
A. C. Watson, Industrial Ins. Sales Fibre Products Div., Corning Glass Works

"I think **Trends** contains very valuable information, and if future issues are as informative and interesting as the first, it will prove of great value to the industry. . . ."
C. K. Lingo, A. C. Engineer, Fla. Power & Light Co.

"Would be very glad to have **Trends** sent to this office . . . material may be helpful in the preparation of our advertising"
C. R. Moffett, Adv. Mgr., Carnegie-Illinois Steel Corp.

". . . This will undoubtedly be of great service to the industry."
L. S. Keilholtz, A. C. Research Engr., Chrysler Corp.

"I was very much interested to receive a copy of the first issue . . . appears to be a very helpful and constructive publication. . . ."
H. L. Fisher, Vice-President, Rickard & Company, Inc.

"We found the first issue of **Trends** very interesting. . . ."
L. J. Galbreath, Prod. Devel. Dept., Revere Copper & Brass, Inc.

". . . there have been so many developments in the air conditioning business that this new publication, I am sure, will be a very welcome service to everyone connected with the problems of air conditioning market. . . . I shall mark this publication for several men in the office who are interested in applications to the air conditioning field."
John J. Curtin, Motor Div., General Electric Co.

". . . This new bulletin can indeed fill a need and if the first issue is any indication then you will not lack material for discussing the current problems on the sales side of air conditioning."
John Grouse, Sales Mgr., Furnace Div., Forest City Foundries Co.

". . . would be glad to have you forward a copy of **Trends** to the properties on the attached list which we operate. We are going into air conditioning this year . . . think your publication will be of considerable help to the managers at our different properties."
W. M. Carleton, Citizens Utilities Co. Minneapolis

". . . more than pleased to receive **Trends** . . . should make interesting reading matter and at the same time can be helpful in judging developments in the field of air conditioning."
E. Szekely, Vice-Pres. & Gen'l Mgr., Bayley Blower Co.

". . . We believe that this publication will be of great service to everyone in the industry and will assist all to pull together instead of shooting out on separate tangents."
O. V. Wooley, Sec.-Treas., Maid-O-Mist, Inc.

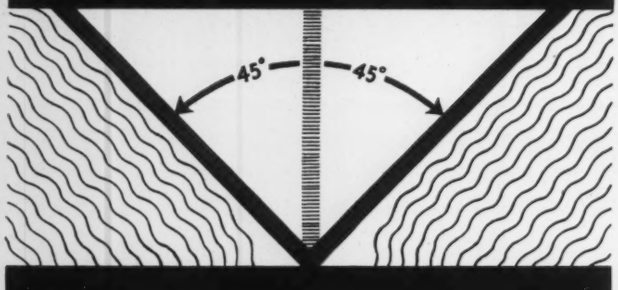
A COMPLIMENTARY SERVICE

No commercial venture, but issued with the compliments of the engineering journals, HEATING, PIPING AND AIR CONDITIONING and AMERICAN ARTISAN, **Trends** is distributed to selected sales, advertising, and administrative executives in the air conditioning industry. Those concerned with the **sales side** of air conditioning who wish to receive **Trends** regularly and have not already requested that they be placed on the permanent mailing list, are invited to do so now. Write on your business letterhead to the address below.

KEENEY PUBLISHING COMPANY, 6 N. MICHIGAN AVE., CHICAGO

"AIR CONDITIONING HEADQUARTERS"

Air Flows Controlled WITH CERTAINTY



TO 45 DEGREES IN ANY DIRECTION
UP OR DOWN RIGHT OR LEFT

Grille bars can be set individually at pre-determined angles before installing; and after the system is operating, they can easily be changed to make any necessary corrections or to meet unforeseen or changed conditions.

Send for catalog and data book.

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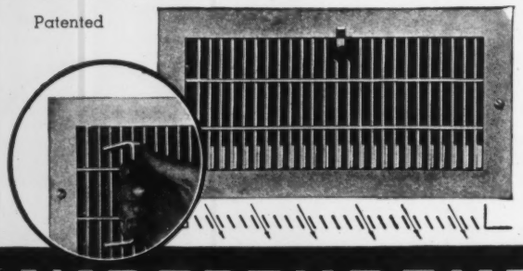


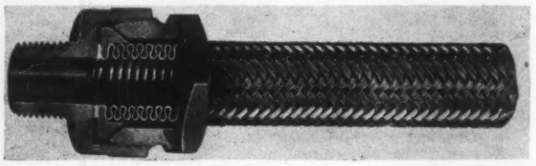
INDEPENDENT
"Fabrikated" adjustable
REG. U.S. PAT. OFF.
DIRECTED AIR FLOW
REGISTERS and GRILLES

In general, the complete unit consists of three parts; collector cells, ionizing assembly, and power pack. These may be furnished assembled in a standard cabinet or as parts for assembly

in existing duct work or special cabinets. Electrical parts are of Westinghouse manufacture.—Pangborn Corp., Pangborn Blvd., Hagerstown, Md.

Detachable Coupling for Flexible Tubing

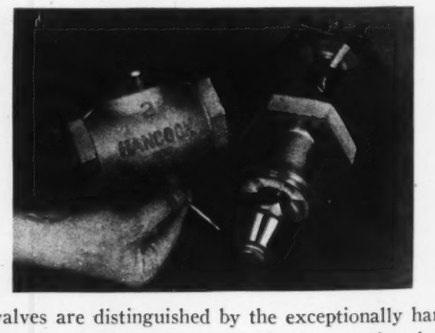
No. 1180—Simplicity is the feature of new "American Heatproof" detachable coupling for use with seamless flexible tubing. It is made in three parts; the end nut, split ring and top part.



Either males or unions are available. Since it can be detached and re-attached without use of special tools or return to manufacturer, it reduces maintenance costs in the use of flexible tubing, the manufacturer says.—American Metal Hose Branch, American Brass Co., 414 Meadow St., Waterbury Conn.

Hard Seats and Discs Feature New Valves

No. 1181—Completion of the 1¼, 1½ and 2 in. sizes in globe and angle patterns of new line of bronze valves was announced last month. Sizes 1 in. and smaller were put on the market a year ago.



These valves are distinguished by the exceptionally hard stainless steel seats and discs with which they are equipped, says the maker. The trim is heat treated to a hardness of 500 Brinell and then machined on a diamond boring machine. This hardness enables these valves to smash paper clips, nails, pipe turnings, boiler scale and sand without leaving a trace of a mark on either the seats or discs, it is said, and gives added resistance

TRIMO
DROP FORGED
●
ALL ALLOY STEEL
●

MAKERS AND DEVELOPERS OF QUALITY PIPE WRENCHES FOR 50 YEARS

Look for the Red Tag attached to every TRIMO

Refrigeration

Air conditions 20 theatres in Baltimore alone—and each installation is paying for itself in 2 to 3 years.

Earning such returns is not unusual with Frick Refrigeration: restaurants increase profits up to 300 per cent; dairymen get Grade A prices for their milk; ice cream and quick freezing plants save up to 34 per cent in horsepower consumed; one-man ice plants produce and store up to 22 tons of ice per day; 50 other businesses find it equally indispensable.

Give your business the advantage of Frick cooling service. Ask for full facts and figures today.

WAYNESBORO, PENNA. U.S.A.

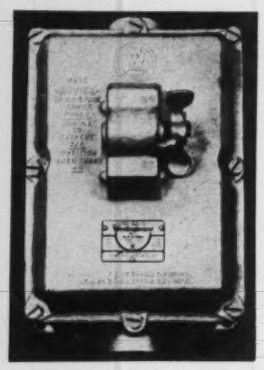
FRICK CO.

DEPENDABLE REFRIGERATION SINCE 1882

to wire drawing and steam cutting and thus lowers maintenance costs. The nail shown was crushed between the seat and disc of the 2 in. valve illustrated.—Hancock Valve Div., Consolidated Ashcroft Hancock Co., Inc., 11 Elias St., Bridgeport, Conn.

Explosion Proof Motor Starters

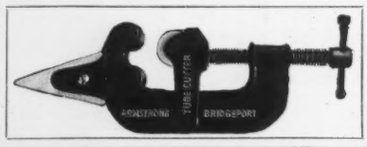
No. 1182—Explosion proof manual motor starters particularly adapted for control and protection of single phase and polyphase squirrel cage motors provide overload protection by the well known disc thermostat, have quick-make and quick-break toggle type mechanism, trip free handle, long life contacts, and corrosion resisting finish on all metal parts.



The starters can be changed from one rating to another by changing heaters and the heater coils may be changed without disturbing the trip mechanism. The overload control does not open the circuit on overloads which do not endanger the motor such as heavy starting currents, but opens the circuit after a proper time lag before damage can be done.—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Tubing Cutter Has Increased Capacity

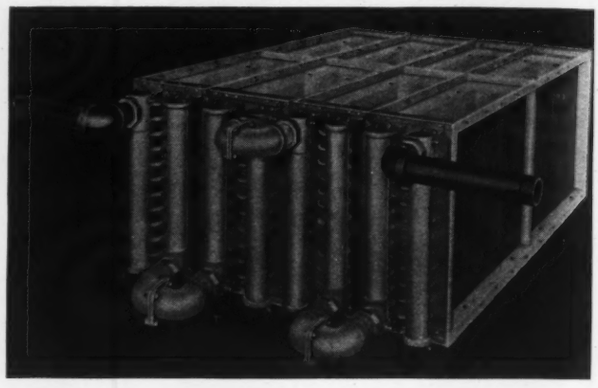
No. 1183—New design tubing cutters recently announced have increased capacity without increased size or weight. The maker states that this frictionless, roller-type cutter with knife-blade wheel makes a rapid smooth cut without denting, twisting or tearing tubing. Each cutter is equipped with knife-blade reamer.



The cutters are made in three sizes. No. 10 with outside diameter range from ⅛ to ⅞ in.: No. 20, range from ½ to 1⅜ in.; and No. 30, range from ⅜ to 2⅛ in.—Armstrong Mfg. Co., 303 Knowlton St., Bridgeport, Conn.

Complete Line of Air Conditioning Coils

No. 1184—Announcement has been made of a complete line of air conditioning coils for use with high and low temperature well water for cooling and dehumidifying and for use with steam or hot water for heating. This new line of coils is cataloged on a package basis with over 550 standard size sections available to meet practically any load requirements.



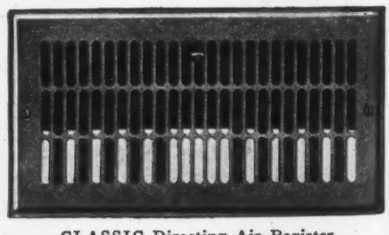
Coils of any depth or size may be obtained in sections and assembled in the field or at the factory by means of standard flanged elbow fittings. Protection against expansion stresses within the coils and between coils and duct is provided by full floating design of end bracket and the coils are manifolded for proper distribution of water or steam.

The AUER "Classic"—
a Pleasing and Popular Design

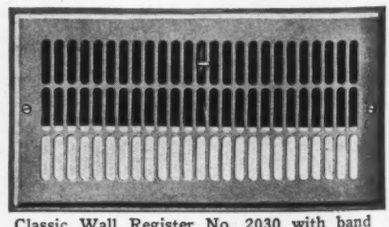
● **The famous AUER "CLASSIC" Register has been widely used both for air conditioning and gravity jobs. It is a face at once decorative and restrained, and lends itself admirably to most interior treatments.**

All AUER Registers have the qualities essential to true register satisfaction: trim modern styling, ample free circulation area, easy installation features, unusual structural strength, finger-tip yet *positive* valve operation.

AUER makes a complete line of Registers and Grilles, in numerous designs and finishes. Air-directional types for every purpose. Write for complete illustrated catalog.



CLASSIC Directing Air Register (Adjustable blades).



Classic Wall Register No. 2030 with band frame.

THE AUER REGISTER COMPANY, 3608 PAYNE AVENUE, CLEVELAND, OHIO

AUER DISTINCTIVE REGISTERS & GRILLES For Air Conditioning *and* Gravity

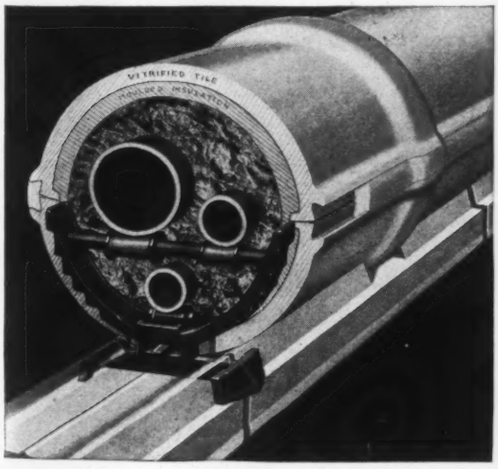
AN ESKIMO NUDIST CAMP?

IT'S cheaper to live in a nudist colony than to wear a genuine seal coat. But the nudist idea is no good for underground steam pipes. It's just as absurd as a nudist in Iceland. On steam lines you need the genuine SEAL of Ric-wiL Conduit—which actually SEALS in the steam, and is unquestionable economy in the end.

Prevent leakage and loss in your steam lines, keep them tight, dry and 90%+ efficient with a Ric-wiL Tile or Cast Iron System, insulated with famous Dry-paC Waterproof Asbestos. Ric-wiL service is complete from design to installation and tests, and is nation-wide. On any sub-soil steam conveyance problem—under-supply, fuel waste, loss in transit—Ric-wiL can give you effective assistance. Write at once for complete catalog and test data.

The Ric-wiL Co. Union Trust Bldg. Cleveland, Ohio
New York San Francisco Chicago
Agents in principal cities

Ric-wiL External Base Drain insures a DRY ditch, which leading engineers say is absolutely necessary for efficiency.



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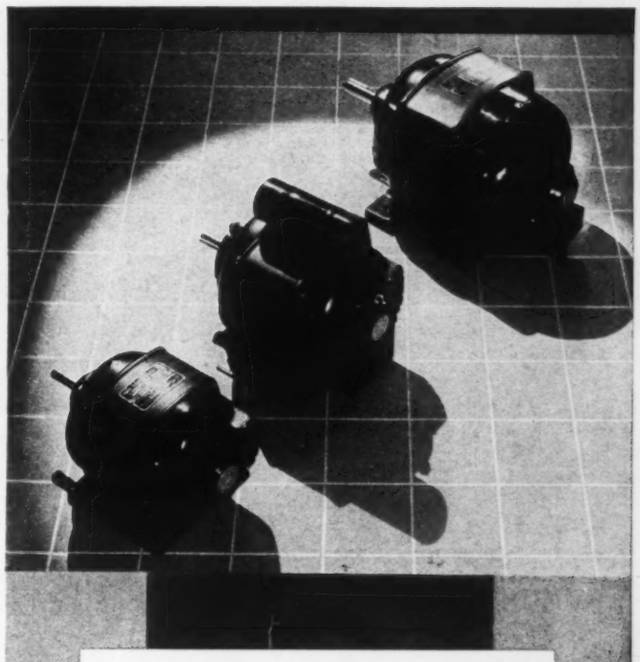
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES



Reinforcing The Sales Appeal

The experienced appliance builder in the market for motors stresses these four points .... 1) the product technically, 2) delivery service, 3) field service, 4) dealer acceptance.

According to an impartial survey conducted by a responsible outside agency, the Leland motor stands among the leaders on all four points. This is significant, because it means that the presence of Leland motors on your appliances will materially reinforce their sales appeal.

State your particular driving requirement and obtain the Leland recommendation.

The Leland Electric Company
DAYTON, OHIO

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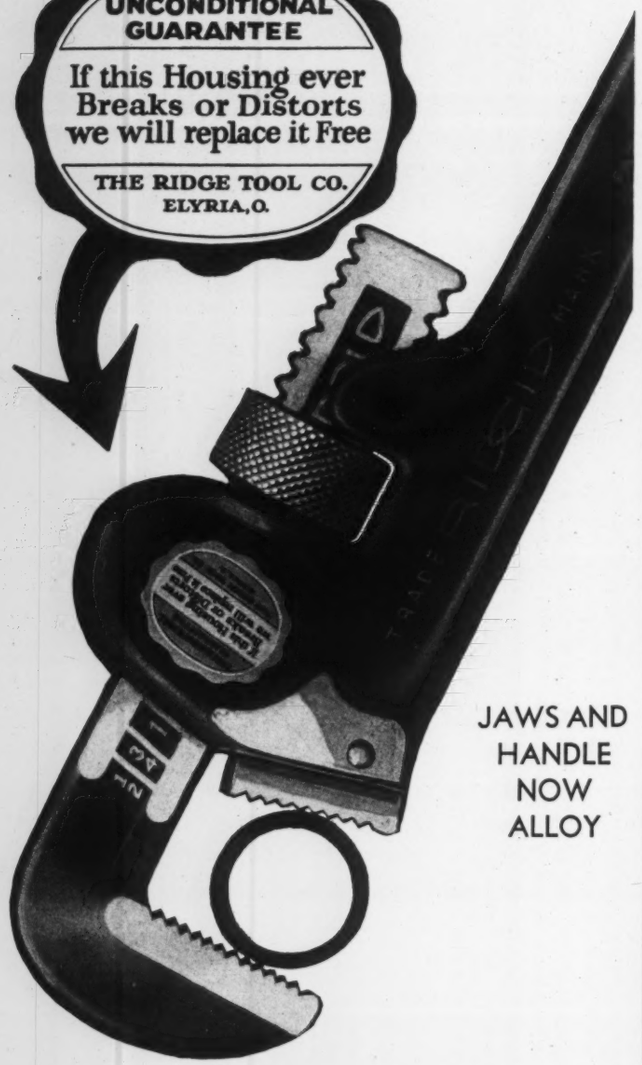
LELAND

UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free
THE RIDGE TOOL CO. ELYRIA, O.



JAWS AND HANDLE NOW ALLOY

A GUARANTEE
That Cuts Your Wrench Repairs
75%

And that adjusting nut spins freely in open housing in all sizes, 6" to 60". The replaceable jaws are non-slip non-lock, made of chrome molybdenum alloy with handy pipe scale on the hook jaw. Try one and you'll see why RIDGID is the most popular make in the world. Ask your Jobber.

THE RIDGE TOOL CO., ELYRIA, OHIO

A RIDGID PIPE TOOL

A drain connection is provided in each section so that where there is possibility of freezing, each section may be drained.—Fedders Mfg. Co., Inc., 57 Tonawanda St., Buffalo, N. Y.

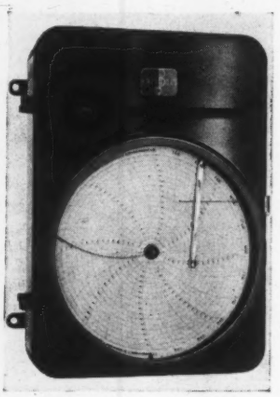
Condensate Return Units

No. 1185—"Unipump" condensate return units are available in nine capacity ratings ranging from 1500 to 30,000 sq ft of radiation. Pumps are fully bronze fitted, with bronze impeller wearing ring and monel metal shaft sleeve for all pumps for pressures in excess of 15 lb per sq in. Through vertical mounting, motor is placed at desirable height above floor and pump is at lowest possible level to insure against vapor binding incidental to handling water at high temperatures.

The units have a built in strainer with clean-out plug for removing accumulations of foreign matter, the strainer having a free opening area about ten times that of the pump inlet. Receivers, regularly furnished in cast iron, are mounted on base plate which contains supply line to pump. Automatic operation of the unit is secured through a float switch actuated by a ball float on a rigid arm within the receiver, and the duplex units have two float operated switches.—Weinman Pump Mfg. Co., 290 Spruce St., Columbus, Ohio.

Round Chart Potentiometer Announced

No. 1186—A new recording potentiometer of the round chart type, known as the "Pyromaster," is available as a pyrometer, tachometer, resistance thermometer, millivoltmeter, and milliammeter and operates on an entirely different principle, which makes possible a number of important exclusive features, according to the maker.



It requires no lubrication whatever; it is not affected by normal plant vibration; there is no mechanical motion of any kind except when a change in the measured quantity takes place; and it can be used under rough plant conditions where the air is laden with dust, moisture, and corrosive fumes. The operating mechanism is made up of five small, compact units which are replaceable. There are no mechanical connections between the galvanometer unit and the other units. Simplicity of the principle makes it possible to place the entire mechanism in a standard model 40M case as is used for recording thermometers, pressure gauges, flow meters, and liquid level gauges.

The pen is actuated in such a way as to follow changes in the measured quantity as they occur and at a rate dependent upon the rate of change.—Bristol Co., Platts Bridge, Waterbury, Conn.

Vane Type Electric Strip Heaters

No. 1187**—Heating air with electricity is facilitated by the use of strip type heaters with the surface extended. The heating unit strip illustrated is identical with the maker's regular strip heater with the addition of metal vanes, each welded to the flat tubular sheath of the unit. This construction assures a high rate of conduction of heat from the unit to the vanes and consequently rapid convection of heat from the vanes. The size of the vanes varies with the type and size of the enclosure and

FIRE

can wipe out these words in a moment but NOT the efficiency, insulating value or the permanence of

CORINCO CORKBOARD

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Write for pertinent information

CORK INSULATION COMPANY INC.
155 EAST 44TH STREET NEW YORK CITY, N. Y.
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MANUFACTURERS OF CORINCO SHEET CORK • CORINCO GRANULATED CORK • CORINCO CORK PIPE COVERING

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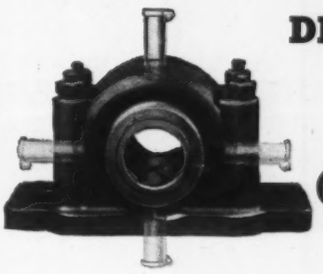


Randall

Right Side

Above is the new Randall Universal D.R.O.R. Pillow Block, showing the four possible mounting positions. Right: Cut-away section of ball of Universal Pillow Block, showing Double Reservoir Oil Return feature.

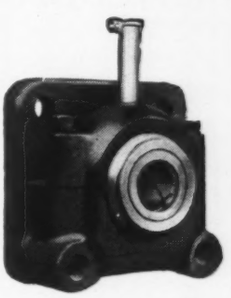
Left Side

THE new Randall Universal Pillow Block with double reservoir oil return feature, fills a need for a pillow block that can be mounted in any position. This type is rapidly being adopted for all types of blower applications.

Inverted

These sketches show how the Universal D.R.O.R. Pillow Block is easily mounted in alternate positions by removing oiler, turning ball and re-inserting oiler vertically.

RANDALL FLANGE-MOUNT PILLOW BLOCK



Randall Flange D.R.O.R. Pillow Blocks are designed especially for mountings on cabinet type air conditioners and unit heaters.

Cut-away section of ball of Flange Type Pillow Block showing Double Reservoir Oil Return feature.

PACIFIC COAST STOCKS

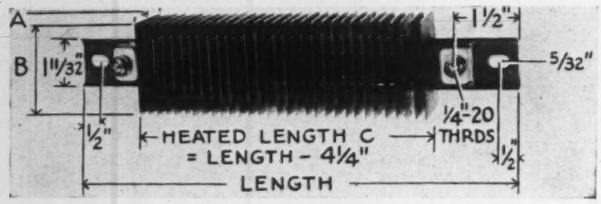
Utility Fan & Mfg. Co.
2528 Santa Fe Ave.
Los Angeles, Cal.

C. W. Marwedel
76 First St.
San Francisco, Cal.

Randall GRAPHITE PRODUCTS CORP.
Dept. 310 609 W. Lake St., Chicago, Ill.

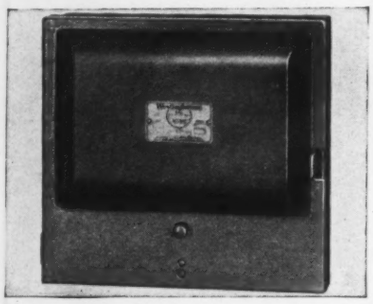
whether free or compressed air is the medium for facilitating convection.

Various terminal arrangements are available, including terminals at each end, which arrangement is of advantage in certain work.—Harold E. Trent Co., 618-640 N. 54th St., Philadelphia, Pa.



Midget Contactors and Line Starters

No. 1188—Midget contactors and line starters comprise a line of remote controlled, reversing and non-reversing magnetic starters for small single phase and polyphase squirrel cage induction motors. The non-reversing contactors are particularly adapted for use with motors driving air conditioning equipment, small compressors, small pumps, oil burners, domestic stokers, small fans and small machine tools, according to the maker.



These devices will fit in unusually small spaces. Coin silver contacts provide long life and maximum conductivity. The operating mechanism is mounted on an insulating base and may be removed as a unit from the cabinet. A thermal overload relay provides protection. Minute control current permits operation from two and three wire thermostats, pyrometers, pressure gauges and other instruments as well as from small push buttons and float switches. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

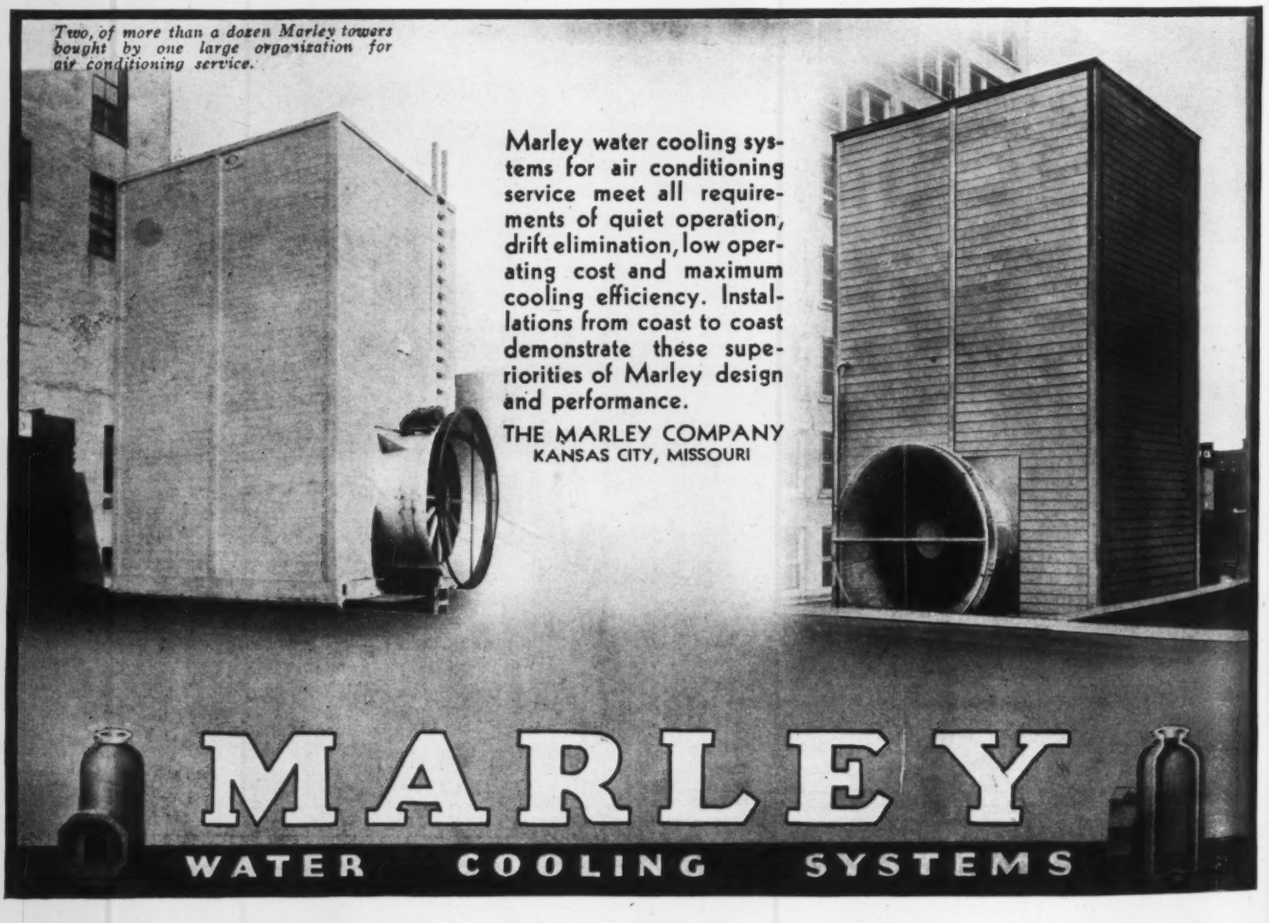
Unit Heater Has Revolving Discharge

No. 1189—All-direction distribution of heat combined with thorough penetration is the unique advantage of a new revolving discharge unit heater. The moving air streams sweep slowly around through 360 deg, covering successively every direction. The air velocity is sufficient to carry the heat to the walls and remote corners. Furthermore, the constantly changing direction of flow causes the air to find its way around obstructions and thus every point is kept at a comfortable temperature, according to the manufacturer. Uniform heating is thus accomplished.

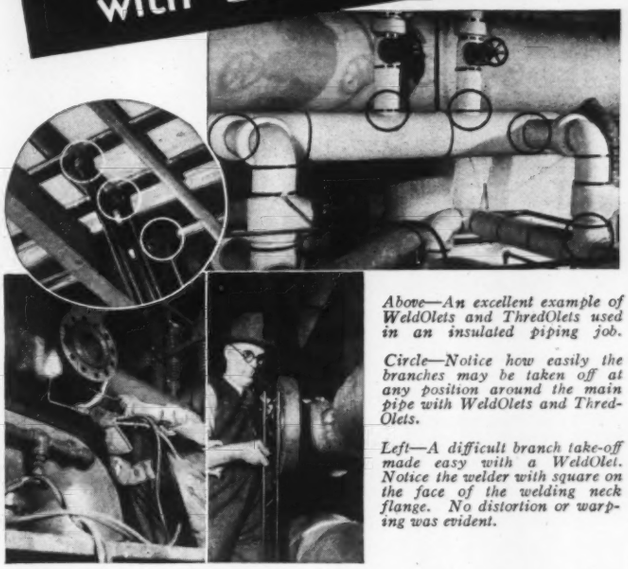
The revolving discharge portion of the new heater may be had separately for attachment on other "Wing" heaters already installed.—L. J. Wing Mfg. Co., 14th St. & 7th Ave., New York, N. Y.

Paint Changes Color When Heated

No. 1190—New heat indicating paints for giving warning of serious temperature changes of process or power equipment are available in two types, one of which changes back to the original color after being exposed to heat and the other of which does not. Five "permanent change" paints and seven "retroactive" paints are offered, the former changing at temperatures ranging from 300 to 734 F, the latter from 122 to 464 F, with a margin of 25 F. The permanent change paints require recoating after each change, and the others are good for from 25 to 50 changes, according to the manufacturer. There are types for interior and exterior use, and they are said to be good for 12 months protection of the surface to which they are applied.—Efkalin Co., 804 E. 141st St., New York, N. Y.


Two, of more than a dozen Marley towers bought by one large organization for air conditioning service.
Marley water cooling systems for air conditioning service meet all requirements of quiet operation, drift elimination, low operating cost and maximum cooling efficiency. Installations from coast to coast demonstrate these superiorities of Marley design and performance.
THE MARLEY COMPANY
KANSAS CITY, MISSOURI
MARLEY
WATER COOLING SYSTEMS

Why be Satisfied with LESS?



Above—An excellent example of WeldOlets and ThredOlets used in an insulated piping job.

Circle—Notice how easily the branches may be taken off at any position around the main pipe with WeldOlets and ThredOlets.

Left—A difficult branch take-off made easy with a WeldOlet. Notice the welder with square on the face of the welding neck flange. No distortion or warping was evident.

CONTRACTORS, Engineers, Architects and others responsible for efficient piping installations have long recognized the advantages of welded piping.

Any piping job, however, is no stronger than its weakest joint and pipe-to-pipe welded intersections do not provide the strength required for high pressures and high temperatures.

Bonney WeldOlets and ThredOlets, designed especially for taking off branch lines, are the ideal fitting for this purpose. The branch is taken off the main line from any position without removing the main pipe. All cutting, forming, fitting or threading are eliminated. The WeldOlet or ThredOlet is simply welded into position, the hole being cut after welding. The heavy external rib in the fittings and their wide base compensates for loss of strength and eliminates distortion in the main line when the hole is cut.

These fittings provide an absolute leak-proof joint. The funnel-shaped outlets of WeldOlets and ThredOlets provide free flow conditions, reducing turbulence and friction to a minimum.

WeldOlets and ThredOlets cost no more to buy (in many cases less) and less to install than any other fittings.

Available with outlet sizes from ½" to 12" for all standard pipe sizes and in metals to meet every piping need.

Write today for Bulletin WT21 giving full details.

"WeldOlets" and "ThredOlets" are fully covered by patents in the U. S. and foreign countries and are trade marks registered in the U. S. Patent Office.

BONNEY FORGE & TOOL WORKS

Forged Fittings Division

Cedar & Meadow Sts., ALLENTOWN, PA.

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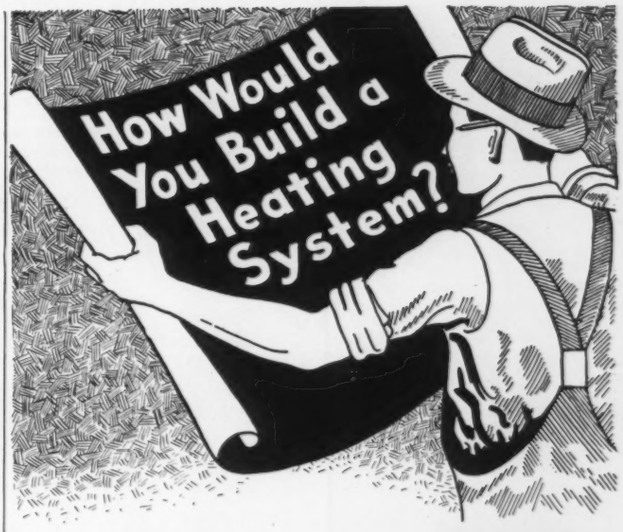
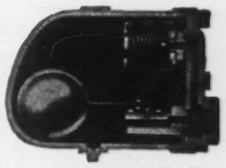
WELDOLETS·THREDOLETS

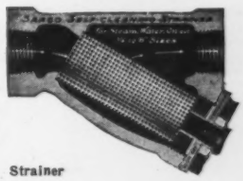


If you were building a heating system for yourself, wouldn't you build it so you could feel certain that it would keep your building as warm as desired in any weather and be on the job for years without repairs?



Float and Thermostatic Trap

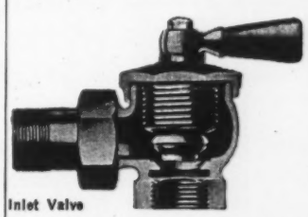
You wouldn't say "I'm going to make a heating system to cost exactly so much." You would spend as much as necessary to insure proper heating and low fuel consumption and eliminate repairs.



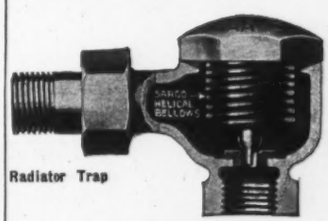
Strainer

SARCO HEATING SYSTEM

was built as you would have built it yourself. How did the men who designed and built the Sarco know what kind of a heating system would give the greatest satisfaction? They knew because they took great pains to find out before it was designed.



Inlet Valve



Radiator Trap

They knew because many of the men who designed and built Sarco Heating Systems have specialized in this line for a quarter of a century. In addition, their experience has been constantly supplemented by the experience of many of the foremost engineers and mechanics in America.

Write for our Catalog O-45.

SARCO CO., INC.

183 Madison Ave. New York, N. Y.

Branches in Principal Cities

SARCO CANADA LIMITED, Federal Building, Toronto, Ontario, Canada

Acquires Pneumatic Control Line

No. 1191—An agreement for the acquisition of the complete line of pneumatic controls manufactured by the National Regulator Co., Chicago, has been entered into between that company and Minneapolis-Honeywell Regulator Co., it was announced last month. As a result, a full range of both pneumatic and electric controls and control systems is available from Minneapolis-Honeywell.

Engineers have recognized that various types of structures require individualized types of heating, ventilating and air conditioning equipment and control. Equipment suitable for a school might not be best adapted to an office building, that for a warehouse might not fill the needs of a theater, and so on. Many jobs require electric control, according to the announcement, and there are other applications when pneumatic control is required. Then again there are installations which require a combination of electric and pneumatic.—Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., South, Minneapolis, Minn.

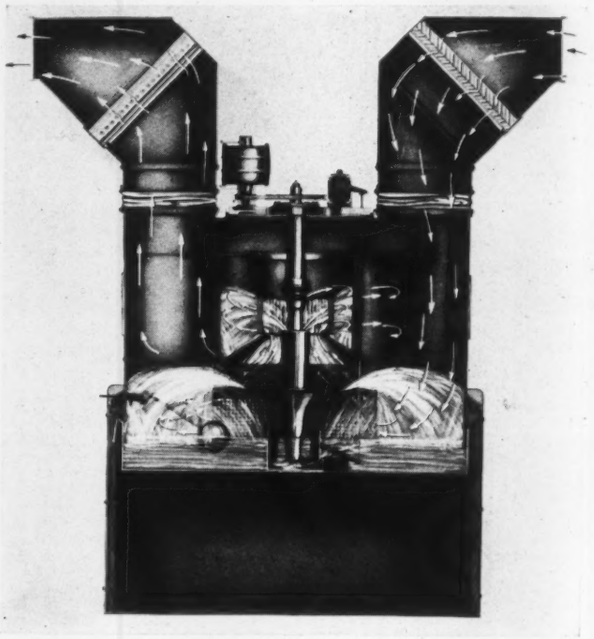
New Process for Making Lead Pipe and Sheet Lead

No. 1192—An improved process for the manufacture of lead pipe was recently announced which results in a product with a number of advantages. With the new method, it is stated that the pipe is accurate to within 0.001 in. in wall thickness, sponginess is eliminated, laminations are absent, and the lead is more compressed and has a tighter grain structure.

The same manufacturer has also announced a new type of sheet lead. Before rolling, the lead is coated with a layer of antimonial lead. When rolled, the sheet has one face of pure lead and the other face coated with antimonial lead. Lead sheets made in this way are stronger and stiffer than those of pure lead and may be used for types of construction for which pure lead sheets cannot be used. At the same time, the corrosion resistant properties of pure lead are retained. Sheets may also be made with lead facing on both sides and antimonial lead inside.—Andrews Lead Co., 26-36 Greenpoint Ave., Long Island City, N. Y.

Washer Conditioner Unit for Smaller Jobs

No. 1193*—New "Hydro-Air System" air washer and conditioner unit for residences and medium sized installations in



restaurants, shops, theaters and manufacturing plants is available in four standard sizes, each one capable of variable capaci-

Patent Nos. { 2,025,973 / 1,850,049

the SAFE CONNECTION
FOR EVERY AIR CONDITIONING AND REFRIGERATION USE

• It can't leak...it can't break...it's stronger than the pipe itself. It's proof against vibration, strain and pressure. Arco Copper-to-Copper—non-porous, corrosion-resisting, and smooth inside, with Full Flow Fittings, to cut down friction loss. Get the story of Wrought Copper-to-Copper—standardize on Arco for equipment or replacement. Great variety of fittings available in sizes from ¼" to 4". Write for details to

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AMERICAN RADIATOR COMPANY
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40 West 40th Street, New York, N. Y.

ARCO
Full Flow WROUGHT
COPPER FITTINGS & PIPE
STOCKED BY JOBBERS EVERYWHERE

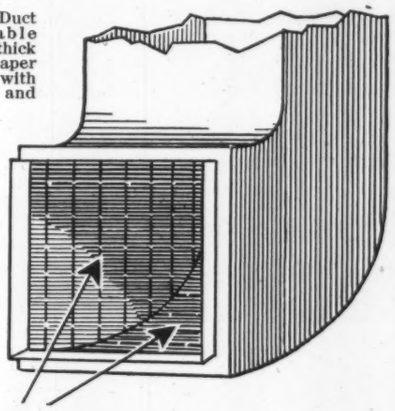
IN Like A LION—

But Always OUT Like a LAMB!

It is surprising what magic a few feet of Ozite Hair Felt Duct Lining can work in a noisy, vibrating air duct. Placed at the entrance, the exit, and possibly one or two of the sharper turns, this efficient duct lining stops the transmission of noise. This flexible material is remarkably easy to apply. It is odorless, fire-resistant and provides lasting protection. Write for samples and specification sheets today!

AMERICAN HAIR & FELT CO.
Merchandise Mart Chicago, Ill.

Ozite Hair Felt Duct Lining is available ½" thick or 1" thick in bats with paper cover or felted with burlap backing and latex facing.



Ozite
HAIR FELT
AIR DUCT LINING

ANEMOSTAT
Gives Draftless Air Diffusion

THOMPSON'S RESTAURANT
Fordham Road, Bronx, New York City

Architect: G. J. Couchois, New York City

Contracting Engineers: The Airtemp New York Sales Corporation, New York

Thompson's customers dine in perfect cool comfort without experiencing the harmful and unpleasant sensation of draft.

Installation Data

Total Length of Restaurant	166′
Height of Ceiling	15′
Length of Rear Ell illustrated	80′
Width of Restaurant in Rear	15′
Velocity in Duct and ANEMOSTAT Neck	1600 fpm
Temperature Differential	20°
Total Volume of Air	9000 cfm
5 ANEMOSTATS distribute each	1250 cfm
1 ANEMOSTAT distributes	2800 cfm

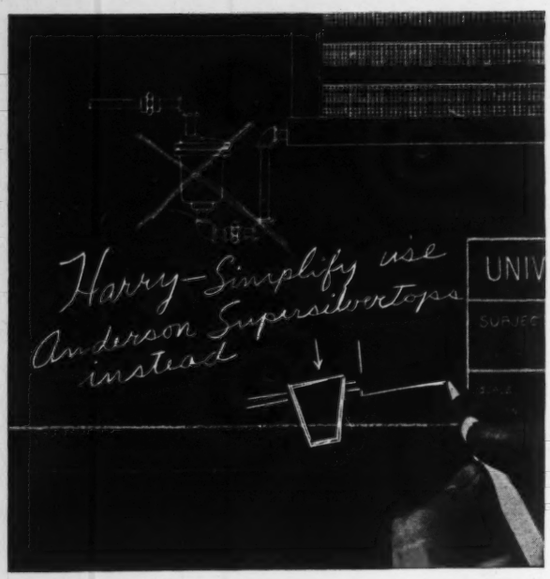
The ANEMOSTAT is an accepted scientific achievement. It has solved major problems of the Air Conditioning Industry by reducing the speed of air flow to such an extent that it is no longer perceptible as a draft and by mixing room air with conditioned air within the device. Its use, therefore, permits greater temperature differentials, smaller ducts, smaller plants, lower installation and operating costs. The ANEMOSTAT can be applied to existing systems as well as to new installations.

"No Air Conditioning System is better than its Air Distribution"

ANEMOSTAT CORP. of·AMERICA
551 FIFTH AVE, NEW YORK CITY

"Simplify"

SAID THE ENGINEER



● *This engineer knows that . . .*

Anderson Super-Silvertops simplify the piping layout.

There are no extra fittings (elbows, nipples or strainers) to buy and install.

The saving in installation time is as much as 60 minutes per trap.

Anderson Super-Silvertops work on vacuum as well as pressure.

They do not leak steam.

Anderson Super-Silvertops have 76% more capacity.

A small Anderson trap does the work of larger, ordinary traps that cost more money.

If you also want to save fittings and labor and have the beauty of neat, simplified piping, investigate Anderson Super-Silvertops.

THE V. D. ANDERSON CO.

1939 West 96th Street • • Cleveland, Ohio

The Only Complete **STEAM TRAP**

ties, by adjustment. The line ranges from 500 cfm to 5400 cfm; in terms of heating from 7500 Btu to 480,000 Btu and in terms of cooling from 1½ to 20 tons.

There are two patented and exclusive features, according to the manufacturer. One is the "Turbinator" which throws two sprays, a heavy one for washing and a mist for humidification. The washed air is then drawn through the "Aqualute," a tapering spiral passage, where it is scrubbed and slowed down in velocity, at the same time eliminating all entrained moisture or free water. It then passes through the discharge header into the ducts.

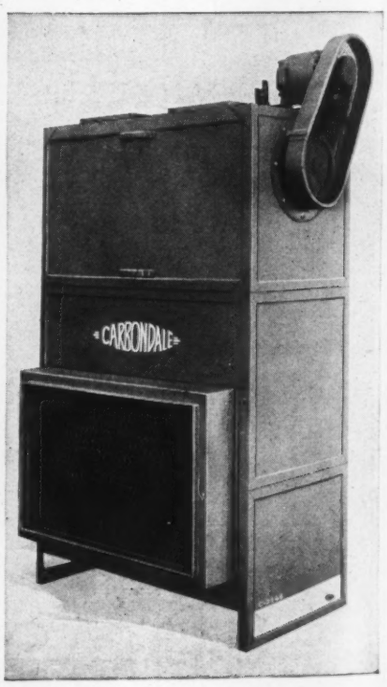
For heating, the discharge header connects with the cold air intake of a warm air furnace or, with a boiler, a heating coil of the correct size is placed in the header. For summer, cooling coils are hung partly submerged in the water pan and connected with a refrigerating compressor of the proper size. There is a super-cooling coil also in the same circuit located at the discharge header. Because the cooling coils are plain and are constantly washed by the spray, the unit will run an entire season without cleaning the coils, it is stated.

A single power assembly, floating on rubber, drives the unit with a ¼ hp motor through interchangeable pulleys and V-belt. The single drive shaft which carries the single or double fan and the "Turbinator" is mounted on ball bearings and packed in grease under pressure.

Recirculated and outside air passes through the intake header in which a standard throw-away filter is located.—Utica Radiator Corp., 2201 Dwyer Ave., Utica, N. Y.

Air Conditioning Units for Wide Capacity Range

No. 1194—New unit air conditioners with a wide range of air and refrigeration capacities announced recently are built on field-tested standardized designs. Each element is a complete and separable section in a compact cabinet, making assembly easy and speedy, according to the manufacturer. One section contains the complete fan assembly with motor, another the complete coil and humidifying assembly, and another the base and cleaning elements. Any section may be shipped or handled separately.



A complete air conditioning job, including cooling and dehumidifying, heating and humidifying, and cleaning and air circulation is accomplished by these units. They are available with or without humidifying and heating elements. Sizes range from 300 to 11,000 cfm, capacities from 2 to 50 tons.

All moving parts are accessible without dismantling the unit. The cabinet is constructed of heavy steel frames, coated inside and out with water and sweat-proof insulation. The outside surfaces are finished in a rust resisting enamel.—Carbondale Div., Worthington Pump and Machinery Corp., Harrison, N. J.

Time Has Proved Them Long Lived—Dependable

Many valves look and work well when new. But what will they be like after years of service!

Although Fairbanks Valves were installed many years ago throughout the 43-story Hotel New Yorker, New York, they are still giving satisfactory service.

Fairbanks Valves have proved their worth in so many hundreds of buildings that you are absolutely safe in specifying them. They are backed by a house with ample resources and more than half a century of reputation for square dealing.

Write for Catalog No. 21.

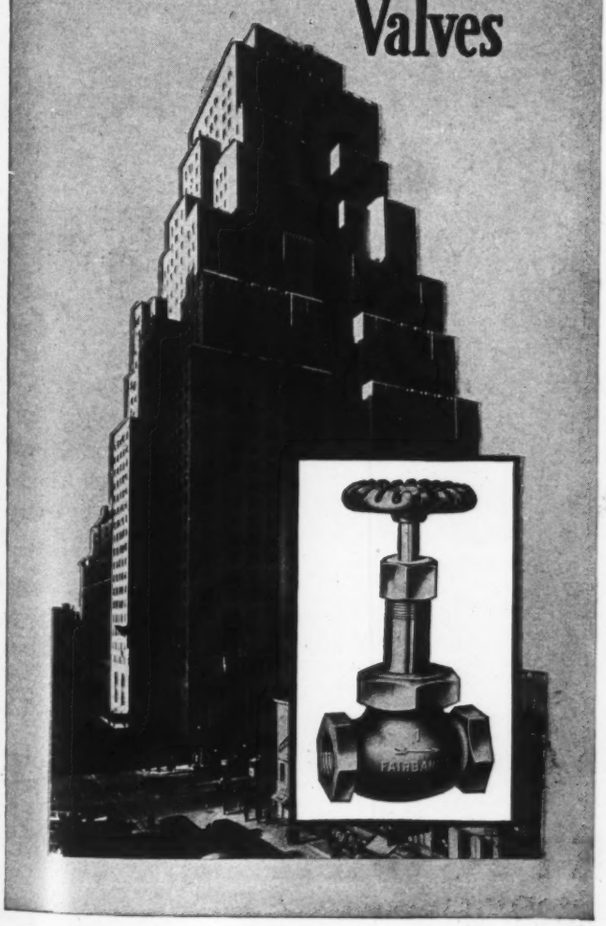
THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

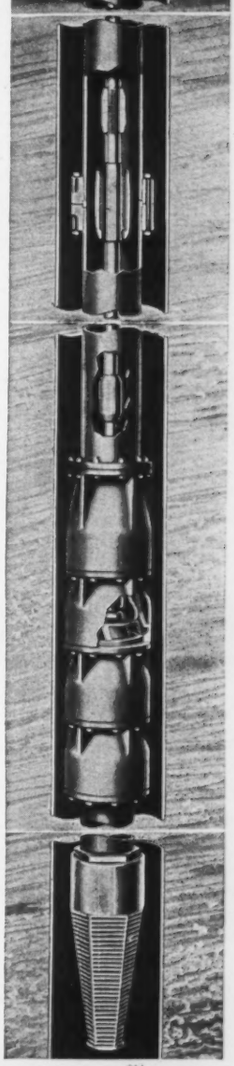
396 Lafayette St., New York, N. Y.

Boston, Pittsburgh—Distributors in Principal Cities
Factories: Binghamton, N. Y.; Rome, Ga.

Fairbanks Valves



INVESTIGATE WELL WATER AIR COOLING WITH DEMING TURBINE PUMPS



Low installation cost . . . low operating cost . . . high efficiency . . . and long life make Deming Deep Well Turbine Pumps a real investment. Where well water is available, Deming Turbine Pumps offer the utmost in economy and dependability in the installation of air cooling systems. For general water supply too, they are equally efficient and economical.

NOTE THESE FEATURES

1. *Water lubrication.* The water, being pumped continuously, floods and positively lubricates all bearings.

2. *Adjustable Impeller Clearance* easily accomplished at any time without removing pump from well. This makes it possible to sustain original high efficiencies over long periods of service.

3. Many more features include *cutless rubber bearings* and *stainless steel bearing sleeves.*

SEND FOR **FREE** DEMING DEEP WELL TURBINE PUMP CATALOG

DEMING Pumps

THE DEMING CO. • SALEM, OHIO

Booklets, Reports and Papers

Air Conditioning for Hotels

At the annual convention of the *American Hotel Association of the United States and Canada* last fall, a forum on air conditioning was held. The discussion showed so clearly that air conditioning occupies a great deal of the thought of hotel operators that the report of the symposium has been printed by the association for the information of its members.

Prof. F. H. Randolph, in charge of the hotel engineering course at Cornell University, introduced the subject with a review of how the human body regulates its temperature, what air conditioning is, and why it is important. He described the refrigeration process and the types of refrigeration equipment used in air conditioning, various types of central and unit air treating plants, and control, pointing out—in reference to the last mentioned topic—that over-cooling should be avoided. He concluded with some remarks on cost, and said that the cost of installation per guest room varies from $200 to $400 per room depending upon the elaborateness of the installation and how easily it may be made. As to operating cost, including only electric power and water, he said this had been mentioned as running from 4c to 25c per guest room per day, and while he had no reason to dispute the figures, he would not be surprised if it approached 60c or 75c per guest room per day of operation.

F. W. Rabe, consulting engineer, Dallas, Texas, was the second speaker and stressed some of the factors involved in the design of an air conditioning system for a hotel and how costs vary over a wide range, as they depend so much on local conditions. He mentioned the use of cooling towers to conserve water and said that on some large installations, without water conserving equipment, the cost of water—figuring probably 4½ to 5 gpm of water per ton of refrigeration—might be prohibitive. (Readers of H. P. & A. C. will remember Mr. Rabe as the author of the article in our June, 1936, issue describing the design of the ballroom air conditioning system for the Adolphus hotel, Dallas.—Ed.)

F. O. Marshall, development engineer with the Pullman Co., then described experiences in air conditioning railroad cars. He said that all but 500 Pullman cars in service are air conditioned, briefly explained the four types of systems used to cool the majority of air conditioned cars (ice actuated, Pullman mechanical, electro-mechanical, and steam ejector), and how they operate. He said it was his opinion that it was only a question of time when all cars, except those in suburban service, would be air conditioned, as what was considered a luxury only two or three years ago is now considered one of the ordinary necessities of train travel. He believed that the hotel industry would find the same thing true.

A number of questions were asked from the floor. One questioner wanted to know if, after all hotels were air conditioned, increased patronage would take care of the increased cost. In his answer, Prof. Randolph compared air conditioning to bathrooms, the idea of every guest room with a bath being a rare thing 20 years ago, but now they are here to stay. During the discussion Paul McSween described the 455 ton air conditioning system of the St. Anthony hotel, San Antonio, the cost of which (for 467 guest rooms and the complete building) was $250,000. Cost of operation, he said, runs 38c per room per day (per guest room, not per occupied room), the entire operating cost being charged to the guest rooms.

Second National Silicosis Conference

Recommendations for the prevention of silicosis through medical and engineering control and for the adequate compensation of those workers disabled as a result of this disease were made

Jointite TRADE MARK CORK INSULATION

Use Mundet Natural Cork Mats to isolate machinery vibration. Efficient and economical. Ask for details.

FOR AIR CONDITIONING

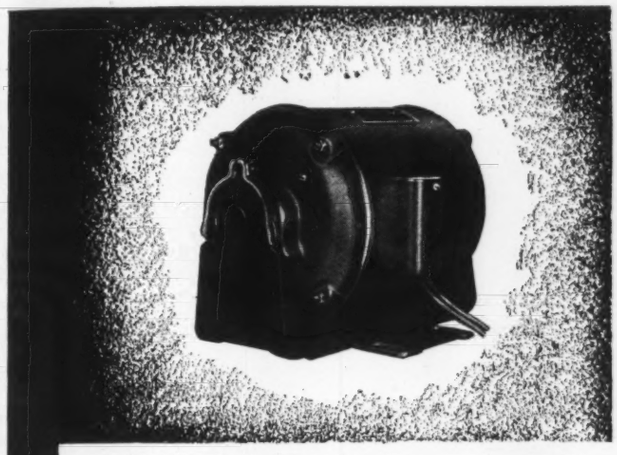
By every standard of service, good Cork is the natural insulator for low-temperature work. It is this fact, together with Mundet's methods in selecting, grading and fabricating its Cork, that makes "Jointite" insulating products so economically and serviceably adaptable to air conditioning requirements.

"Jointite" products include Corkboard and moulded Cork pipe covering, in standard lengths and thicknesses.

Write or wire for further information.

MUNDET CORK CORP.

450 SEVENTH AVE., NEW YORK
OFFICES IN PRINCIPAL CITIES



REASONS WHY

Wagner Motors are Preferred for AIR CONDITIONING EQUIPMENT

1 ***They are reliable.*** All motor parts and completed motors are carefully tested to meet exacting specifications according to the highest electric motor standards—an assurance to users that Wagner motors are reliable, free from defects and will last a good long time if properly used.

2 ***They are economical.*** Actual tests show that Wagner motors consume very little electric current, do not require much care, and operate smoothly and easily under all types of load conditions.

3 ***They will give satisfactory service.*** Wagner motors of today are the result of constant improvement in their mechanical design and efficiency, gained by 45 years of experience in building and designing motors for industry and the home. These years of experience have enabled Wagner's engineers to determine the characteristics of motors that are best for satisfactory service.

4 ***They can stand rough treatment.*** Wagner motors have rolled-steel frames—strong, rigid—will not get out of alignment—unbreakable.

5 ***They require very little attention.*** The life of motors depends upon the conditions of operation to which they are subjected and the care they receive. Wagner motors are so constructed that wear between moving parts is reduced to a minimum. In addition, Wagner motors are equipped with large oil wells and have special lubrication systems so that only periodic oiling is necessary.

6 ***They are well-designed.*** Due to precision of manufacture, careful selection of materials and parts, and intelligent engineering, Wagner Motors have all the features that contribute to efficiency, and yet are unusually compact in design.

7 ***Convenient service facilities.*** Wagner maintains 25 branch offices, warehouses, and service stations in all parts of the country. Each branch carries a complete stock of parts available for immediate shipment. Thus, when there's trouble with any type of motor, Wagner can give better and quicker service.

The above are just a few of the many reasons why Wagner motors are preferred. Many motor buyers prefer Wagner motors because they know that the Wagner line is so diversified in types and ratings that they can get, without special designing, exactly the right motor for their job. Others prefer Wagner motors because they like the cooperation and helpful assistance the Wagner sales-engineers give them when solving their power-drive problems.

When considering your next motor application or installation problem, avail yourself of Wagner's service. Wagner engineers will be glad to work with you and help you select the correct motor for your job. Descriptive literature will be sent upon request.

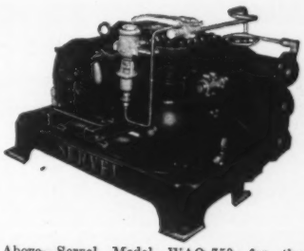
MS 137-IL

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, U.S.A.

THE HEART

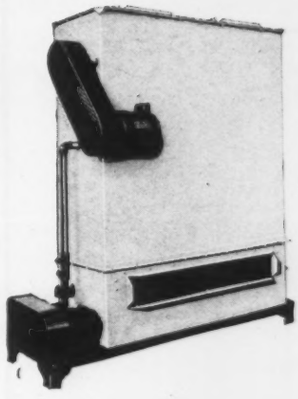
of every Air Conditioning System

Is the REFRIGERATION COMPRESSOR . . . . . .



Above—Servel Model WAO-750 for the big, profitable intermediate air conditioning market.

Servel refrigerating machines of 5 to 20 tons capacity are available with highly efficient multiple shell-and-tube counter-flow condensers for use on city water or with the highly economical evaporative condenser (right) exactly balanced to match each machine size.



Efficient performance! Long-lived dependability! All-around satisfaction! Everything that your customers have a right to expect from the air conditioning systems you install depends largely on the refrigeration compressor you use. Make sure that it's right!

Servel, a world-famous pioneer in low-pressure refrigeration, offers machine units in all popular sizes—with twelve models, ranging in capacity from ½ ton to 20 tons, designed specifically for air conditioning. The time-proved dependability of these compressors removes all element of doubt from the minds of the user, the contractor and the distributor.

If you haven't seen Servel's interesting new air conditioning catalog, mail the coupon—today—for your free copy.

In addition to its regular line of compressors, Servel builds special machine units for quantity purchasers whose requirements are not met by the standard models.

SERVEL

Air Conditioning

and Commercial Refrigeration

For Latest Air Conditioning News—MAIL TODAY! (HP&AC-3)

SERVEL, INC., Electric Refrigeration and Air Conditioning Division, Evansville, Indiana.

Gentlemen: Without obligation to me, please send a copy of your newest air conditioning catalog to

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to Secretary of Labor Frances Perkins at the Second National Silicosis Conference held in Washington on February 3. Detailed reports embodying their findings and conclusions were submitted to Secretary Perkins by four committees of experts appointed as a result of the first national conference on this subject held April 14, 1936 under the sponsorship of the Department of Labor.* These committees were: (1) Prevention of Silicosis through Medical Control. (2) Prevention of Silicosis through Engineering Control. (3) Economic, Legal and Insurance Phases of the Silicosis Problem. (4) Regulatory and Administrative Phases of the Silicosis Problem.

Approximately 150 representatives of labor, management and the medical, legal and engineering professions, together with state administrators, government officials, and insurance men assembled to hear the reports of the committees and to discuss their contents. Sessions were held in the Department of Labor auditorium. The morning session was devoted to the presentation of the summary reports, while the afternoon meeting consisted of discussion.

The complete reports are so voluminous that it is possible to give here only a few of the highlights of the findings and recommendations of the committees. Summarized reports will be printed within the near future, and it is expected that the complete reports, with appendices, will be available at a later date.

Silicosis may be defined as "A chronic disease due to the breathing of air containing silica (SiO_2), characterized anatomically by generalized fibrotic changes and the development of miliary nodulation in both lungs, and clinically by shortness of breath, decreased chest expansion, lessened capacity for work, absence of fever, increased susceptibility to tuberculosis (some or all of which may be present), and by characteristic roentgenological findings."

In the layman's language, silicosis is a disease of the lungs in which the normal lung tissue is replaced by fibrous scar tissue due to breathing air containing silica dust.

Unfortunately there is no known cure for silicosis—but *silicosis can be prevented.*

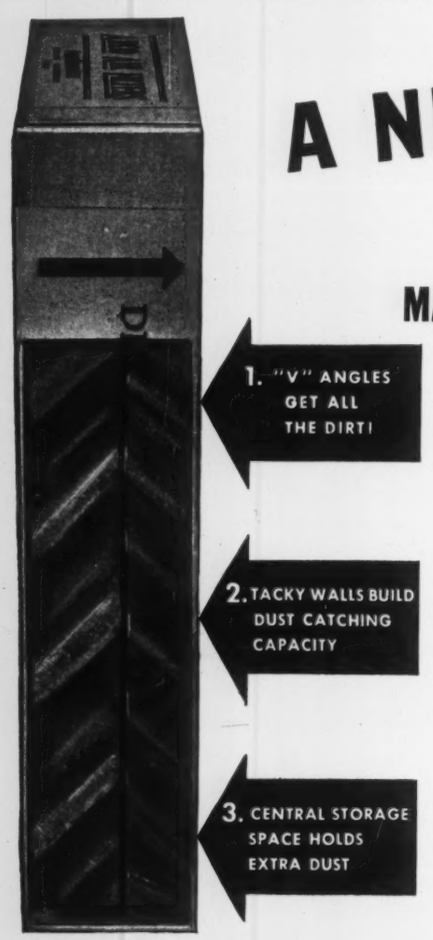
Although accurate statistics relative to the number of workers who have silicosis are lacking, reliable estimates, based upon actual surveys made, indicate that of the 49 million workers in the United States, only one million (2 per cent) are in any way exposed to the hazard. Perhaps half of this number, 500,000 (1 per cent of the total), are exposed to a serious hazard. Approximately 110,000 (2/10 of 1 per cent of the total) have silicosis in some degree, but it is likely that the number of workers who suffer any work disablement at this time from this disease is on the order of 4,000 to 5,000 (a small fraction of 1 per cent). This calculation is based upon medical examination of men actually at work and does not include those already permanently detached from their employment by reason of disabling silicosis.

The million workers who are exposed in some degree to a silica dust hazard fall naturally into four main classes: (1) A percentage of the 4,000 to 5,000 workers who are completely or partially disabled because of silicosis and whose difficulties are further complicated with tuberculosis. (2) The remainder of the 4,000 to 5,000 who have silicosis and disability in some degree, but no tuberculosis. (3) The 105,000 who have silicosis, but no disability and no tuberculosis. (4) The 900,000 who are exposed to silica dust, but who do not have silicosis.

Group 1—From the standpoint of the men in Group 1, the problem is a serious one, and there seems to be no doubt in anyone's mind that these workers should be removed from employment and compensated for total disability just as if they had been incapacitated by accidental injury.

Group 2—The remainder of the 4,000 to 5,000 workers who have silicosis and disability in some degree, but no tuberculosis, should in the majority of cases continue to work. Every study conducted thus far confirms the fact that the great majority

*See Heating, Piping and Air Conditioning, August, 1936, p. 438.



A NEW KIND OF FILTER

for Air Conditioning

MAKE IT A PLUS FEATURE ON YOUR EQUIPMENT

THESE are the points to look for in the filters you use on your equipment. 1. "V" angle construction which makes the air change direction quickly and scrubs it clean. 2. Side walls with a sticky coating that catches dirt and increases efficiency with use. 3. A space between the two wafers which acts as an added storage space for the dust that is collected.

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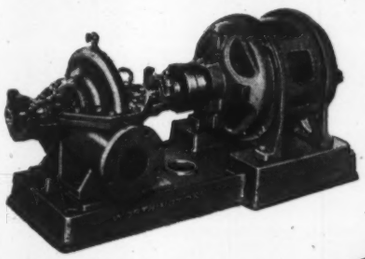

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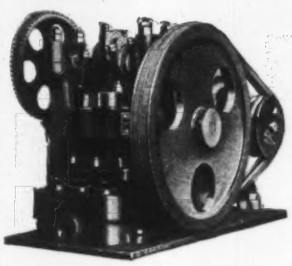

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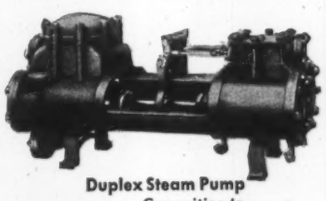

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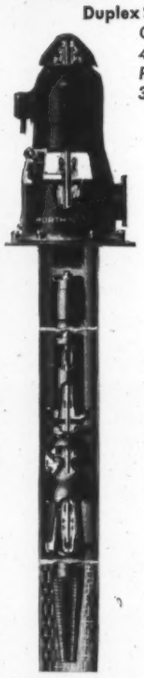

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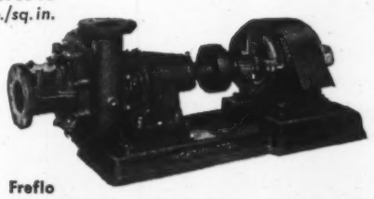

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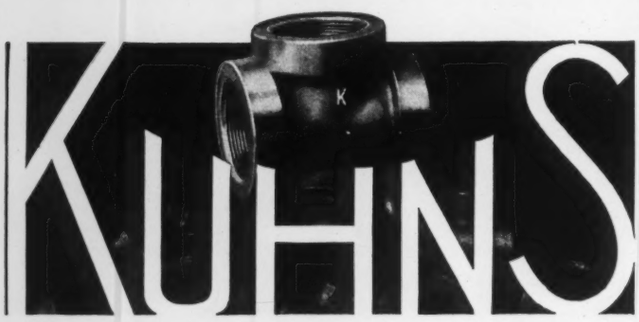

of these men will not necessarily progress from bad to worse, provided the dust is kept to a safe limit.

Group 3—To the 105,000 workers who have silicosis, but no disability and no tuberculosis, the problem is not particularly serious. It is generally agreed that, if the dust is properly controlled at all times, such workers would be as well off in continuing at their present jobs as if they were discharged or transferred to other employment. Therefore, such men should be permitted to continue work at their regular occupations, provided the dust is controlled.

Group 4—For the benefit of the 900,000 workers who are exposed to silica dust but who do not have silicosis, all emphasis again should be placed upon the application of known methods of controlling dust.

Silica dust is found in many industrial operations, but the hazard is acute only in such industries as metal mining; anthracite coal mining; quarrying, drilling, and tunnelling in granite, ganister, and sandstone; smelting and refining; foundries; potteries; glassworks; stone products; grinding; buffing; sandblasting.

It should not be assumed, however, that all establishments in the industries listed are hazardous. To tell whether or not a given operation is hazardous three things must be determined: (1) The concentration of dust in the air—number of dust particles per cubic foot of air. (2) The chemical composition of the dust—percentage of free silica. (3) The size of the silica dust particles—measured in microns. (A micron is 1/25,000 in).

To obtain a definite correlation of the factors of concentration and composition, it is suggested that the dust count (in millions of particles per cubic foot) be multiplied by the percentage of free silica in the dust. If the result is under 5 million, one can be almost sure that the conditions are safe. For example, 10 per cent (free silica) times 30 million (particles per cubic foot of air) equals 3 million—safe.

Physicians familiar with the subject agree that accurate diagnosis can be made only by taking into consideration the man's past occupational and medical history, his present complaints, a careful physical examination and x-ray of his chest, and a laboratory examination of his sputum. And in addition to these data, the careful physician should also consider the man's environment; that is, he should know the number of years he has been exposed to silica dust, as well as the dust count, composition, and particle size.

Contrary to popular belief, silicosis is slow to develop. Usually it takes seven years or more of exposure to silica dust for a worker to contract the disease. It is said that a few cases have been known to develop in as short a period as 1½ years, but these were under extreme and unusual conditions. On the other hand, many workers have labored under ordinary exposures to silica for more than 30 years without demonstrating any trouble whatever that could be diagnosed as silicosis.

In emphasizing the preventability of silicosis, the committees are unanimous in agreeing that the proper application of known methods of control will reduce dust to safe concentrations. In general there are three ways to prevent silicosis; first, by preventing the creation of silica dust; second, by preventing the dispersion of dust into the atmosphere of a working area; and third, if it is impossible to apply the first two methods, by the use of personal protective equipment such as respirators to prevent the inhalation of dust.

Detailed recommendations as to the part which employers, employees, engineers, insurance companies, legislators, and administrators, and others can play in preventing the disease are listed by the committees. Details are given in the summarized reports. The recommendations include such items as compliance with laws, rules, and regulations, plant design and renovation, good housekeeping, provide ventilation, isolate dusty processes, wet methods, exhaust systems, respiratory protective equipment, etc.

The committees have also recommended certain principles with

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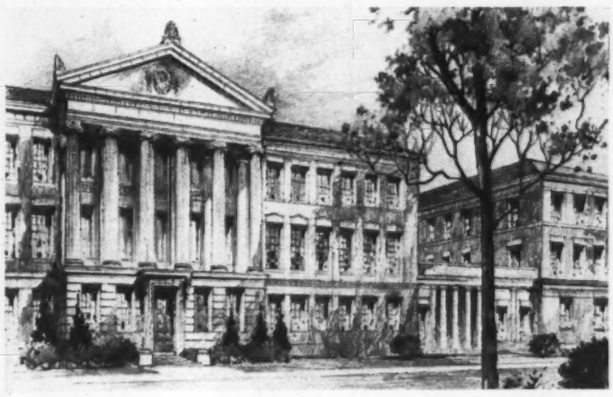

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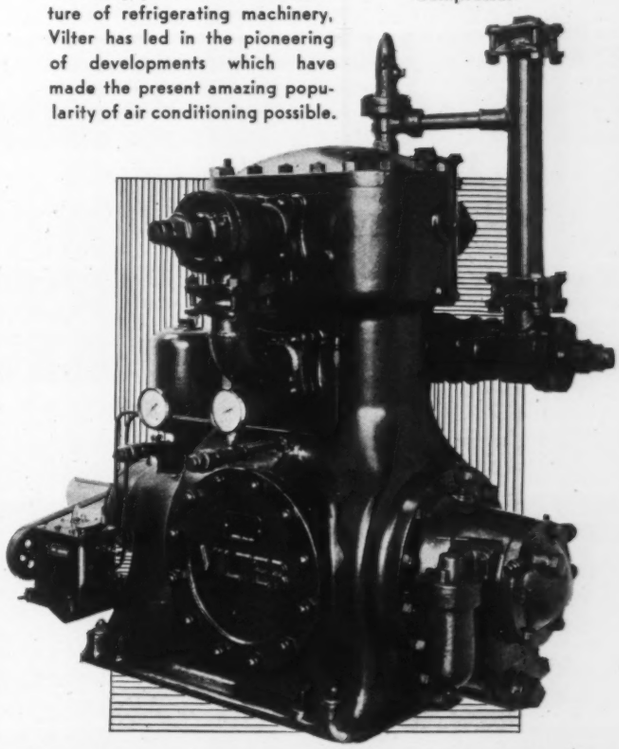

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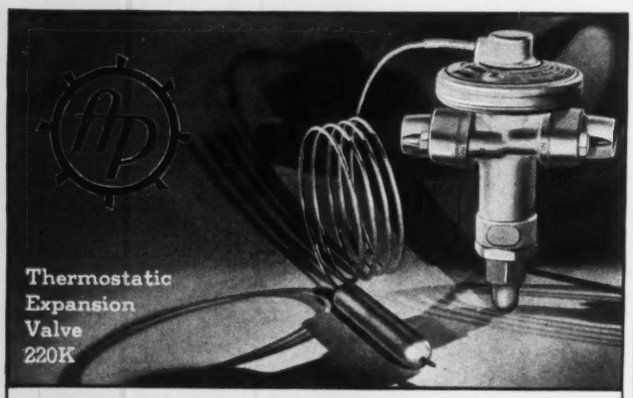

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respect to providing adequate compensation for workers disabled as a result of silicosis. These suggest compulsory coverage for silicosis in the compensation acts of all states and urge as great a degree of uniformity among various state laws in this respect as is feasible. It is recommended that the employer insure his obligation for compensation either through self-insurance subject to the posting of adequate funds, or with an authorized insurance institution. The committees see no reason to distinguish, from a compensation standpoint, between workers disabled by injury and workers disabled from silicosis.

However, the accrued liability question, with respect to which silicosis is unique, complicates this situation. Several suggested methods of treatment are given in the reports.

The detailed work of the conference was carried out under the guidance of the Division of Labor Standards, U. S. Department of Labor, V. A. Zimmer, Director.—R. CAMPBELL STARR.*

"Trends" Surveys Hotel Air Conditioning

The current issue of *Air Conditioning Trends* analyzes the hotel air conditioning market for the information and guidance of engineers, contractors, and manufacturers. Size of the market, extent to which it has absorbed air conditioning, sales potentials, and the views of hotel men and air conditioning engineers are some of the subjects dealt with. A supplement tabulates figures on the extent to which air conditioning is used in hotels from data reported by 31 public utilities, 11 manufacturers, and as reported by 257 hotels, and gives figures on number of hotels in various regions, average number of rooms per hotel, dining room seats per 100 rooms, food sales, and hotel rates.

The leading article, entitled "Complete Air Conditioning for Hotels Expected to Reach New Heights During Coming Year," surveys the hotel industry as a market for air conditioning, points out it has been barely scratched. Fifty-one hundred hotels having 100 or more rooms are prospects for guest room or restaurant air conditioning, according to the article. Of their 1,000,000 rooms, only 4000 are now conditioned. One-tenth of the restaurants in the better class of hotels are now air conditioned.

Views of hotel men on air conditioning are given in other articles. F. W. Andrews, executive vice-president of one hotel chain, is convinced that the chain hotel as well as the independent is coming to air conditioning, but that air conditioning is only one of the problems entering into hotel operation. Thomas D. Green, president of the *American Hotel Association,* points out that air conditioning is one of the livest topics of discussion in the hotel world. T. V. Loran of the Hotel Statler, St. Louis, believes that the air conditioned hotel brings business to the entire city, does not feel that the commonly raised objection that "when all hotels in a city are air conditioned there will be no advantages" holds water. Thomas D. Carson, president of the Hotel Carlton, Washington, D. C.—one of the first in the country to air condition guest rooms†—believes that air conditioning justifies its cost, gives pertinent advice on installation from his own experience.

F. W. Rabe, in a signed article, advises study of hotel operating problems, states that operation economics must be stressed. Charles M. Hart, specialist in hotel design, presents the designer's view of hotel conditioning.

Air Conditioning Trends is published by the Keeney Publishing Co., publisher of HEATING, PIPING AND AIR CONDITIONING.

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*Executive Secretary, National Silicosis Conference.

†See "Carlton Hotel Air Conditions," by T. D. Carson, HEATING, PIPING AND AIR CONDITIONING, August, 1936, p. 439, for a description of this installation.

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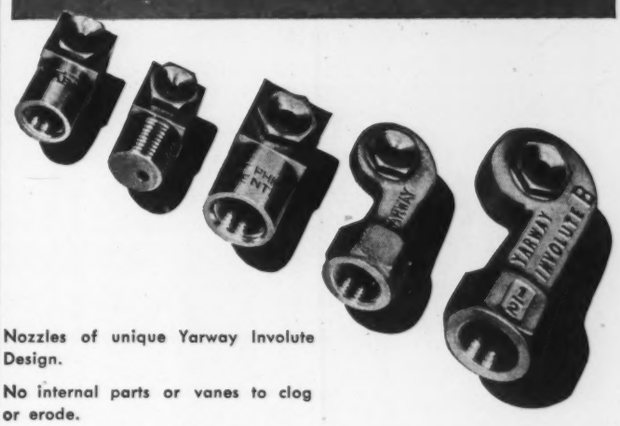

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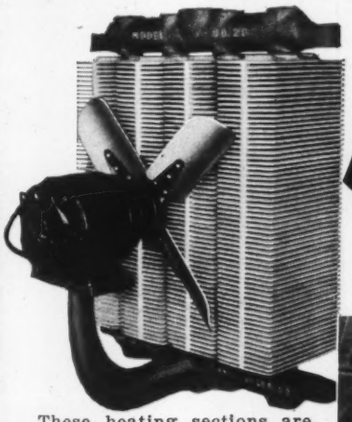

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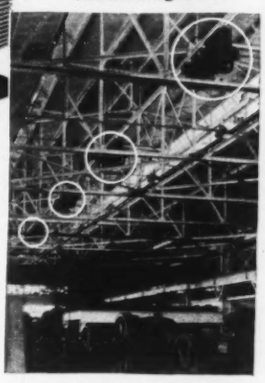

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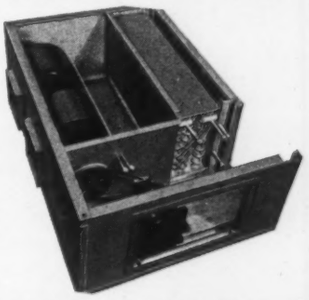

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Abnormal Air Conditions in Industry

The paper on "Abnormal Air Conditions in Industry: Their Effects on Workers and Methods of Control", by Prof. C. P. Yaglou, Department of Industrial Hygiene, Harvard School of Public Health, read before the Harvard Tercentenary symposium on the environment and its effects on man, has been published in the January, 1937, issue of *The Journal of Industrial Hygiene and Toxicology*. (Vol. 19, No. 1, pp. 12-43). It is of direct interest to plant and air conditioning engineers, as the difficulties in the solution of industrial ventilation and air conditioning problems are described and the possibilities and limitations of air conditioning as applied to three representative industries—textile mills, mines and steel mills—are discussed.

It is shown that abnormal air conditions in hot and cold trades affect working capacity, accident liability, sickness, and mortality. Although heat or cold *per se* are the causes of acute conditions, chronic effects appear to be largely due to sudden temperature changes and the liability of chilling the body while warm and perspiring. Respiratory diseases and rheumatism are the chief affections in hot and cold trades where workers are subjected to exposure to great temperature changes.

Control of such industrial hazards is partly an engineering and partly a medical problem involving four lines of procedure. (1) Change or mechanization of the process. (2) Local control of the atmosphere surrounding the process, such as thermal insulation, screens for radiant heat, exhaust hoods or canopies, etc. (3) Control of the general workroom atmosphere by ventilation or air conditioning. (4) Preventive medical methods applied to the worker. Professor Yaglou says that in the control of acute and chronic effects, ventilation and air conditioning methods are not always effective and often have to be supplemented or superseded by medical methods. such as prophylactic methods applied to the worker, control of fatigue and hygienic habits, periodic examination and prompt remedial measures, and selection and gradual adaptation of workers according to their physiological response to heat or cold and sudden temperature changes.

It is pointed out that industrial air conditioning today is mainly for the processing of materials which are affected by temperature and humidity, and that the human benefits are less tangible and difficult to prove; industrial air conditioning in hot and humid trades solely for the comfort and health of the workers is therefore a rare exception. That both worker and process are concerned in air conditioning is indicated by the description of humidification in textile mills. In cotton weaving rooms it has been shown that the number of yarn breakages decreases with increasing relative humidity, but after a certain point the ability of workers to fix the breaks is reduced, because of adverse effects of the atmospheric conditions on the weavers, with a reduction in overall efficiency of production.

A bibliography listing 163 references on the subject is given.

Conventions and Expositions

Oil Burner Institute: Oil burner and air conditioning exposition and convention, March 15-19, Commercial Museum, Philadelphia, Pa.

International Association for Testing Materials: 2nd International Congress, April 19-24, London, England. Honorary Secretary, K. Headlam-Morley, 28 Victoria St., London, S.W.1.

Conference and Exhibit on Air Conditioning and Automatic Heat: April 21-23, Mechanical Engineering Dept., University of Wisconsin, Madison, Wis. (Three morning sessions on air conditioning, and one afternoon session each on stokers, oil burners, and gas heating.)

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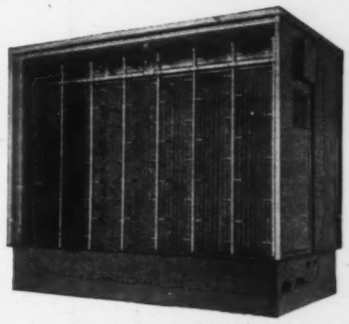

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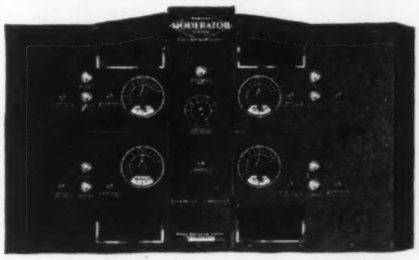

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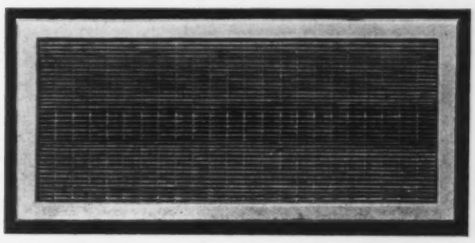

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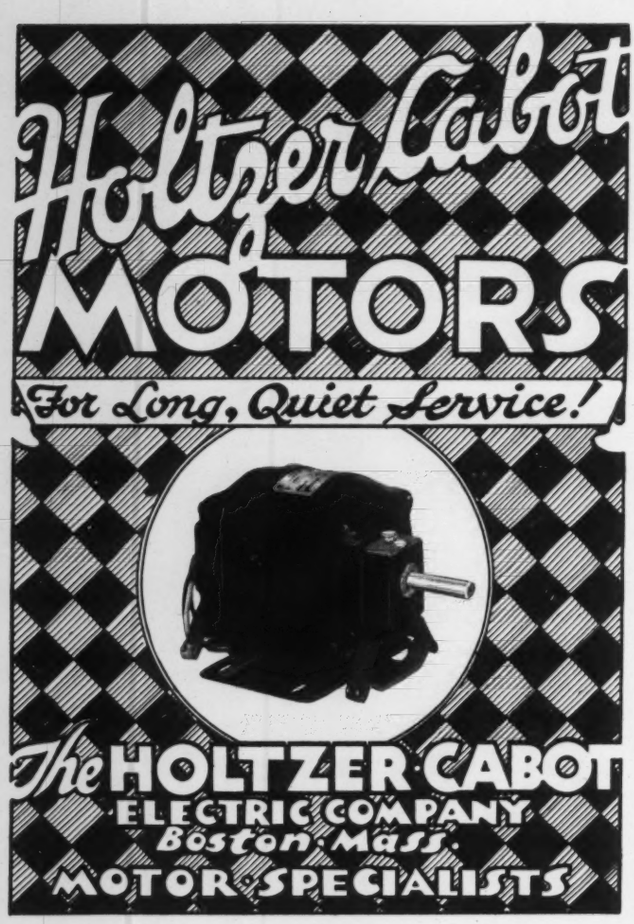

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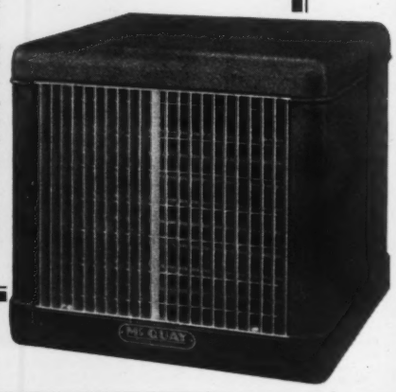

McQUAY, INC.
Minneapolis, Minn.

American Foundrymen's Association: Annual convention and exhibit, May 3-7, Milwaukee, Wis. Headquarters Office, 222 W. Adams St., Chicago, Ill.

Heating, Piping and Air Conditioning Contractors' National Association: Annual convention, May 17-19, Hotel Nicollet, Minneapolis, Minn. Secretary, Joseph C. Fitts, 1250 Sixth Ave., New York, N. Y.

National District Heating Association: Annual convention, May 25-28, Book-Cadillac Hotel, Detroit, Mich. Secretary-Treasurer, Wm. H. Sanford, Engineers' Club Building, 1317 Spruce St., Philadelphia, Pa.

Short Course in Coal Utilization: May 25-27, University of Illinois, Urbana, Ill. D. R. Mitchell, Department of Mining and Metallurgical Engineering, 212 Transportation Bldg., Urbana, Ill.

American Society of Refrigerating Engineers: Spring meeting, May 25-27, French Lick Springs, Ind. Secretary, David L. Fiske, 37 W. 39th St., New York, N. Y.

Smoke Prevention Association: Annual convention, June 1-4, Hotel Pennsylvania, New York, N. Y. Secretary, Frank A. Chambers, 139 N. Clark St., Chicago, Ill. Fuel burning and air pollution exhibition to be held in conjunction with convention in ballroom of Hotel Pennsylvania, May 31-June 5.

American Society for Testing Materials: Annual meeting and exhibit of testing apparatus, June 28-July 2, The Waldorf-Astoria, New York, N. Y. Headquarters Office, 260 S. Broad St., Philadelphia, Pa.

Universal Craftsmen Council of Engineers of the World: Power show and mechanical exposition, August 3-7, Hotel Stevens, Chicago, Ill. General Chairman, W. T. Walters, 7965 Phillips Ave., Chicago, Ill.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 166.

No. 2281. AIR CIRCULATORS: Roto-Beam Corp., 3300 Indiana Ave., Chicago, Ill. Folder describing room air circulators for stores and offices, exhaust fans, and intake fans with spun glass air filters.

No. 2282. BEARINGS: Johnson Bronze Co., New Castle, Pa. 40 p. catalog of leaded phosphor bronze electric motor service bearings illustrating over 200 bearings, describing them, and giving specifications. Information is also included on bronze cored and solid bars, hexagon bars, lead-base and tin-base babbitt and general purpose phosphor bronze bearings.

No. 2283. CIRCUIT BREAKERS: General Electric Co., 1 River Rd., Schenectady, N. Y. 8 p. bulletin on circuit breakers for office buildings and industrial plants. 230 volts a-c, 125 to 250 volts d-c, 15 to 600 amperes; 600 volts a-c, 250 volts d-c, 50 to 600 amperes; 5,000 and 10,000 amperes interrupting rating. The equipment and its application is described and characteristic curves are shown.

No. 2284. CONVECTORS: Modine Mfg. Co., 17th St., Racine, Wis. 32 p. catalog on copper convectors describing the advantages of the "split system"; the advantages of copper convectors; and showing numerous grille designs and giving construction details for the concealed and recessed units and floor cabinet and wall cabinet models, two types of which are available, one designed specifically for steam and the other for hot water. Typical specification, capacity, and dimension tables are given.

No. 2285. DRIVES: Gates Rubber Co., 999 S. Broadway, Denver, Col. 8 p. bulletin describing some of the features of the new high speed Burlington Zephyr trains and the uses of some

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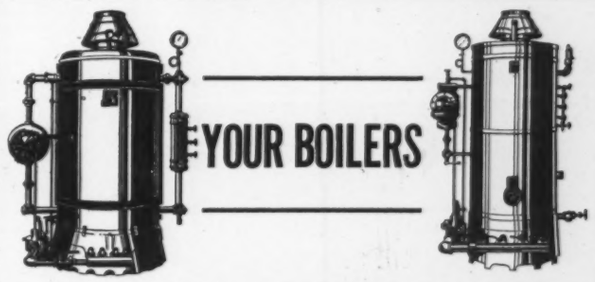

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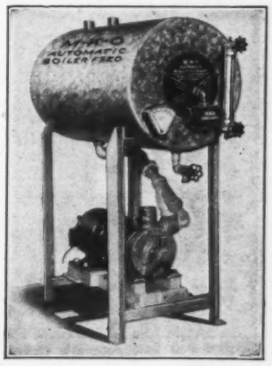

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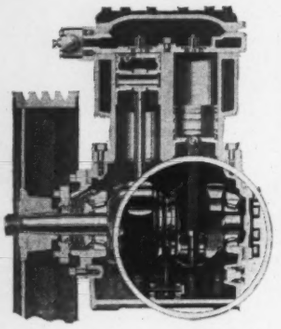

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No. 2287. FITTINGS: S. R. Dresser Mfg. Co., 490 Fisher Ave., Bradford, Pa. Folder describing new "Style 65" compression fittings for making flexible connections on plain end pipe. Fittings conform to specifications for 150 lb malleable fittings on the sizes ⅜ to 2 in. Features are fully described.

No. 2288. GASKETS: Goetze Gasket & Packing Co., Inc., 60 Allen Ave., New Brunswick, N. J. 24 p. bulletin commemorating 50 years of experience and describing the growth of the company since its founding in 1887. The various steps in the manufacture of gaskets are illustrated and briefly described.

No. 2289. GAUGES AND METERS: Julien P. Friez & Sons, Inc., 4 N. Central Ave., Baltimore, Md. 4 p. bulletin on air meters, draft gauges, air filter gauges, and the new pitot static head. The instruments are described and illustrated and applications and operation explained.

No. 2290. HEATING SURFACE: John J. Nesbitt Inc., State Rd. & Rhawn St., Holmesburg, Philadelphia, Pa. Series of 4 p. bulletins describing the features of heating surface with steam distributing tubes, construction of the surface, how it can be used in solving the control problem, why it is non-freezing, how expansion is cared for, and results that have been achieved with it.

No. 2291. HEAT TRANSFER SURFACE: Young Radiator Co., 709 Mead St., Racine, Wis. 24 p. bulletin on heat transfer surface for air conditioning and commercial applications with information on design and construction, applications, and complete tables of technical data on net weights, pressure drop, face velocities, final temperatures and condensation. Engineering information is given on cooling with water, including typical examples, tables of pertinent data, and a psychrometric chart.

No. 2292. LEATHER PRODUCTS: Alexander Bros., Inc., 406 N. 3rd St., Philadelphia, Pa. 32 p. catalog of leather products for industrial use including belts on which complete technical data are given; belt lubricant; water proof cement; round leather belting; leather packings; industrial leathers; valve leathers, etc.

No. 2293. LUBRICATION: The Texas Co., 135 E. 42nd St. New York, N. Y. 12 p. issue of "Lubrication" (Vol. 23, No. 1) devoted to lubrication of natural gas machinery, including a description of the gas engine and covering cylinder lubrication, engine deposits, compressor design, the storage and handling of lubricants, and explaining the lubrication problem.

No 2294. METAL SPRAYING: Metallizing Co. of America, Inc., 1218 Long Beach Ave., Los Angeles, Calif. 36 p. booklet comprising a photographic story of the metal spraying process and covering its numerous applications.

No. 2295. MONEL: The International Nickel Co., Inc., 67 Wall St., New York, N. Y. 48 p. booklet entitled "Strength Plus," describing the various uses of Monel and other high nickel alloys for various applications including steam lines; condensing and cooling; regulators and meters; pipe lines; pumps; refrigeration and freezing, and giving technical facts, data and mill forms. This publication is designed to be of value in the selection of materials for various industrial purposes.

No. 2296. OIL BURNING EQUIPMENT: Preferred Utilities Mfg. Corp., 33 W. 60th St., New York, N. Y. 52 p. catalog of automatic heating and air conditioning equipment, including oil burning, boiler and warm air conversion units, draft adjustors, dampers, draft gauges and draft testing outfits, thermometers and gauges, boiler control, condensate control, fuel oil valves, oil heaters, and numerous other specialties and equipment. A tech-

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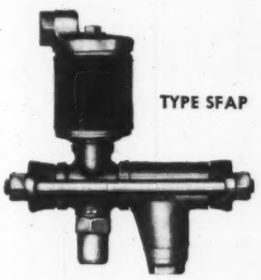

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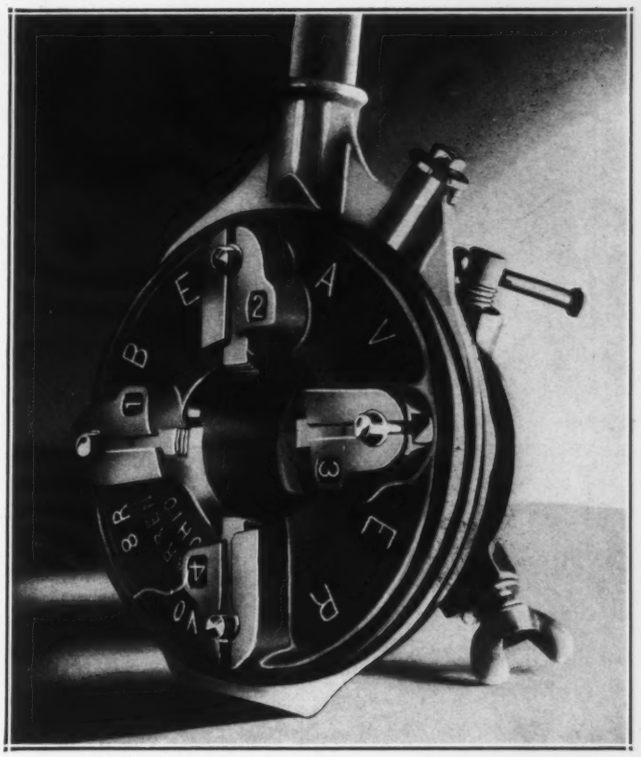

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No. 2301. STOKER FIRED BOILERS: Pierce Butler Radiator Corp., 701 Nichols Ave., Syracuse, N. Y. 4 p. bulletin describing features of stoker fired boiler for providing uniform heat at low fuel cost, and giving a rating and dimension table.

No. 2302. THERMOMETERS: C. J. Tagliabue Mfg. Co., 540 Park Ave., Brooklyn, N. Y. 16 p. catalog of etched stem thermometers and hydrometers, including etched stem armored and pocket thermometers. Complete listings of *A. S. T. M.* thermometers and *A. P. I.* certified hydrometers are included, and useful data on scale graduations, correction for emergent stems, instructions for the use of hydrometers, and conversion tables are given.

No. 2303. VALVES AND FITTINGS. Alloy Steel Products Co., 1300 W. Elizabeth Ave., Linden, N. J. 12 p. bulletin on "Aloyco" stainless steel valves and fittings, describing the features of design and the various types of valves, and giving dimension tables. Screwed, flange, and reducing flange fittings are illustrated and described.

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